GEOLOGICAL SURVEY OF CANADA

OPEN FILE 3705

A survey of hydroclimate, flooding, and runoff in the Red River Basin prior to 1870

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ACKNOWLEDGEMENTS

The writer is grateful to Betty Harder and Maggie Fredrickson for their assistance in the preparation of the manuscript, to Weldon Hiebert for drafting the figures, and to the staff of the Manitoba and Hudson's Bay Company Archives.

19th CENTURY HYDROCLIMATE OF RED RIVER BASIN

INTRODUCTION

The 19th Century was the culmination of a 400-500 year period of generally deteriorated climate known as the Neoboreal, or Little Ice Age during which widespread areas of the northern Hemisphere, and the mid-latitudes in particular, experienced cooler and wetter conditions (Lamb, 1982). Although various writers have placed different temporal boundaries on the Little Ice Age, most consider it to have extended until the late 19th Century. Thus the period of most of the fur trade era, the establishment and growth of the Red River Settlement and early Winnipeg, and the beginning of instrumental records of climate and streamflow in the Red River basin, belonged to a different climatic regimen, involving changes in the predominant circulation patterns, different climatic normals, and presumably, different responses in the natural and human phenomena dependent upon them.

For several reasons, the Red River might be expected to be particularly sensitive to changes in climate since these are most clearly expressed at the peripheries of bioclimatic regions where relatively small changes may produce major shifts in boundaries. The drainage basin of the Red River is in such a region. The basin lies astride the transition from humid forested regions in the east to subhumid and semiarid conditions to the west, receiving runoff from both. This difference between these regions might have been even more pronounced under the natural vegetation of the pre-settlement period. The basin approximates the modern average winter position of the "Arctic Front" and is in the normal path of storm tracks crossing the northern Great Plains from their origins in the lee of the Rocky Mountains, particularly those from Alberta. The runoff ratio (runoff÷precipitation) for the basin is very low, generally only 3-7% of precipitation. Thus, averaged over a long period, evapotranspiration accounts for more than 90% of precipitation. The basin is, then, particularly sensitive to even small changes in runoff ratio caused by changes in precipitation, evapotranspiration, and/or land surface condition.

From an analysis of floodplain sediments in small valleys tributary to the upper Mississippi River, Knox (1993) concluded that "modest climatic changes" (1-2°C in mean annual temperature and 10-20% in mean annual precipitation) caused "large and sometimes abrupt adjustments in both magnitudes and frequencies of floods in the Upper Mississippi Valley." (p. 432). Ashmore and Church (in press) suggested that future climate change would produce an 'amplification effect' whereby future precipitation changes would cause disproportionately larger changes in discharge, that the changes in higher magnitude flood flows would be disproportionately greater than changes in mean flow, and that streamflow in regions with very low runoff ratios would be most sensitive to climate change. The effect of this 'amplification' would be to shift the flood frequency curves upward and to cause them to diverge, i.e. the effect would be greater at the upper regions of the curves. Comparing a wet period (1941-1960) and a dry period (1921-1940), they concluded

> The eastern prairies...seem to be an area of highly sensitive flood flow regimes. In this region (whereas) mean annual flow increases between 1920-1940 and 1940-1960 were of the order of 30% in the prairie source streams, mean annual flood increases are typically 50-100%. The upward shift in flood frequencies during wetter periods is proportionally greater in the eastern prairies than in the mountain-source rivers of the prairies... Historic records in the eastern prairies show a marked sensitivity to climatic fluctuations, with large reductions in streamflow and maximum flows during warmer and drier years. Warmer winters will reduce snow accumulation leading to reductions in magnitude of the annual snowmelt flood. During historical warmer periods the size of the 20 year flood has decreased by a factor of 2-4 in large prairie streams, indicating considerable climatic sensitivity. (Ashmore and Church, in press)

Ashmore and Church were discussing the effects of future climate warming on streamflow but the argument could be applied equally in reverse, i.e. for changes projected backwards in time, and from warmer to cooler conditions.

Runoff in the basin is strongly concentrated in the freshet period; about 60% of average runoff occurs in April-May, rising to about 70% if June is included, and all modern floods of consequence have occurred within the snowmelt period. Although each flood has its own distinct features, the following are considered to be typical factors in the formation of large spring floods:

- An abnormally wet late summer and autumn which saturates the ground prior to freezeup.
- Severe cold and freezeup prior to the first significant snowfall to permit frost to penetrate deeply.
- A cold winter with heavy snow over the entire watershed and minimal thawing, producing a heavy standing snowpack at the end of winter.
- A late spring which slows the release of snowpack water, followed by a rapid transition from sub-freezing to melting temperatures.
- Above normal late-winter precipitation near the breakup period or during the melt period. This may occur as a heavy late winter snowfall (as in 1966 or particularly 1997) or significant rainfall during the period of flood formation (as in 1950 or 1979).

In flood frequency analysis, it is important that the data be drawn from as homogeneous a time series as possible, yet all of these causative factors are subject to climate change and might be expected to have shifted significantly between the 19th and 20th Centuries. Since the 1950 flood intensified interest in the hydrologic history of the

Red River, much has been learned about the nature of the 19th Century late Little Ice Age climate of the Great Plains region of the United States and Canada but this growing body of literature has not been incorporated into the understanding of the nature and causes of 19th Century floods and the general hydrologic environment in which they occurred. In Part A of this report, the literature relating to the 19th Century climate of the Red River basin region will be surveyed to provide such a context.

Instrumental records in Winnipeg, although the longest in western Canada, began only in 1872. Fortunately, historical materials available in the Manitoba and Hudson's Bay Company Archives and other documents of the period provide abundant first-hand observations of climatological and hydrologic phenomena from 1793 onward. These sources have been used in studies of the largest 19th Century floods (eg. Canada Department of Resources and Development, 1953a) and selectively for other purposes (eg. Allsopp, 1977; Blair and Rannie, 1994; Rannie, 1983,1990) but no comprehensive survey of 19th Century weather has been compiled. Also, existing lists of 19th Century floods have generally been based on incomplete surveys of the archival records (eg. Miller and Frink, 1984, Table 4 in Part B) and, in consequence, a number of events have been overlooked. As Kemp (1982) concluded:

> [These sources] provide the only available documentary material of any kind in much of central North America for the period preceding the European agricultural colonization of the plains and, if allowance is made for the imprecision and subjectivity associated with such records, they can provide an insight into the weather and climate of the area, as well as an indication of their impact on the activities of those who lived and worked there. (Kemp, 1982, p. 40)

The problem of incorporating historical data into flood frequency analysis has been considered by Gerard and Karpuk (1979), among others.

> In many instances...hydrometric records cover only a relatively short period of time. The probability estimates of rarer events is then poor. Such estimates could be significantly improved by the consideration of historical data...other than the standard hydrometric data. The effort to collect such historical data is usually limited. This is because only historical information on the most extreme floods is usually used quantitatively. Any other historical data that can be collected are generally qualitative and of varying reliability and therefore are difficult to incorporate into quantitative analysis. (Gerard and Karpuk, 1979, p. 1153).

For the Red River, only the three largest events of the pre-instrumental record (1826, 1852, 1861) are normally used in frequency analysis because their peak stages and discharges have been estimated with tolerable accuracy. Other significant events have not been included, probably because, as Gerard and Karpuk observed,

> ...it is difficult to allocate a rank and record length to each reported peak...Because of this only the one or two highest stages in the historical record are commonly utilized in estimating high water probability distribution, the major emphasis being placed on hydrometric records for which both a rank and record length can usually be simply allocated. Much potentially useful information in the historic record is therefore rejected. (Gerard and Karpuk, 1979, p. 1164).

The importance of including the largest historical events in flood frequency analysis has been demonstrated by Booy and Morgan (1985). Their analysis showed, among other things, a dramatic decrease in the Return Period for design floods on the Red River when the two largest historic floods were added to the recorded flow series. Their conclusions, however, also assume that the historic floods were drawn from the same frequency distribution as the recorded series.

The writer has compiled a database of archival materials consisting of approximately 19,000 entries from 1793 to 1870. Although a large number of these are not in themselves informative (eg. references to "cold" in January), taken collectively they do provide a portrait of the nature of the seasons in the Red River Valley for the majority of years in the 19th Century prior to 1870. More important for the purposes of this report are the abundant direct references to river conditions, particularly those which are unusually high or low, and the weather conditions which produced them. In Part B of the report, these materials will be used to reconstruct the flood history of the Red and Assiniboine Rivers in more detail than has been done in previous studies. Part C will extend the analysis to non-flood years by inferring the general runoff conditions in the basins for as many years as the data allow.

PART A

REVIEW OF LITERATURE

Instrumental data exist in the period prior to 1870 but they are scattered in time, inconsistent, and of doubtful reliability. Consequently, with the exception of a study by Wahl and Lawson, most research on 19th Century climate has relied on phenological indicators such as tree rings, breakup and freezeup, lake sediments, fire history, etc.

TEMPERATURE

Wahl and Lawson (1970) compared average temperatures in the United States from 1850-1870 with 1930-1960 normals (Figure 1). Although their maps are highly generalized, they indicate that the region of the southern portion of the Red River basin had colder temperatures in all seasons in 1850-70 in comparison to 1930-60 and on an annual basis was >1°C cooler, one of the largest departures in the United States. The greatest seasonal departures (>-1°C) were for winter (January-March) and early fall (September-October); summers (July-August) were somewhat cooler (c.-0.5-1.0°C) and the least difference was in spring (April-May) (c.-0.5°C). The small spring departure is potentially significant in the context of flooding because it would suggest more rapid warming from colder winter temperatures and later breakup to only slightly cooler spring temperatures, with the consequent greater possibility of more rapid snowmelt and larger spring peak. A cooler, shorter summer would reduce evapotranspiration and possibly increase the "effective moisture" status of the basin at the beginning of fall.

RIVER BREAKUP AND FREEZEUP: Perhaps the clearest phenological indicator is provided by dates of river ice formation and breakup. Because of the river's importance to early occupants of the Red River Settlement, the dates of river freezeup and breakup are commonly reported in archival materials. From these records, and from newspaper accounts after 1874, Rannie (1983) reconstructed the timing of these events from 1815 to the beginning of modern records in 1908. Median breakup dates for 20-year periods from 1820 to 1980 are given in Table 1.

TABLE 1
BREAKUP, RED RIVER, 1821-1980

	Median	Maximum		Median	Maximum
1821-1840	April 18	May 8	1901-1920	April 11	April 25
1841-1860	April 20	May 6	1921-1940	April 6	April 20
1861-1880	April 26	May 3	1941-1960	April 11	April 23
1881-1900	April 22	May 2	1961-1980	April 15	April 26

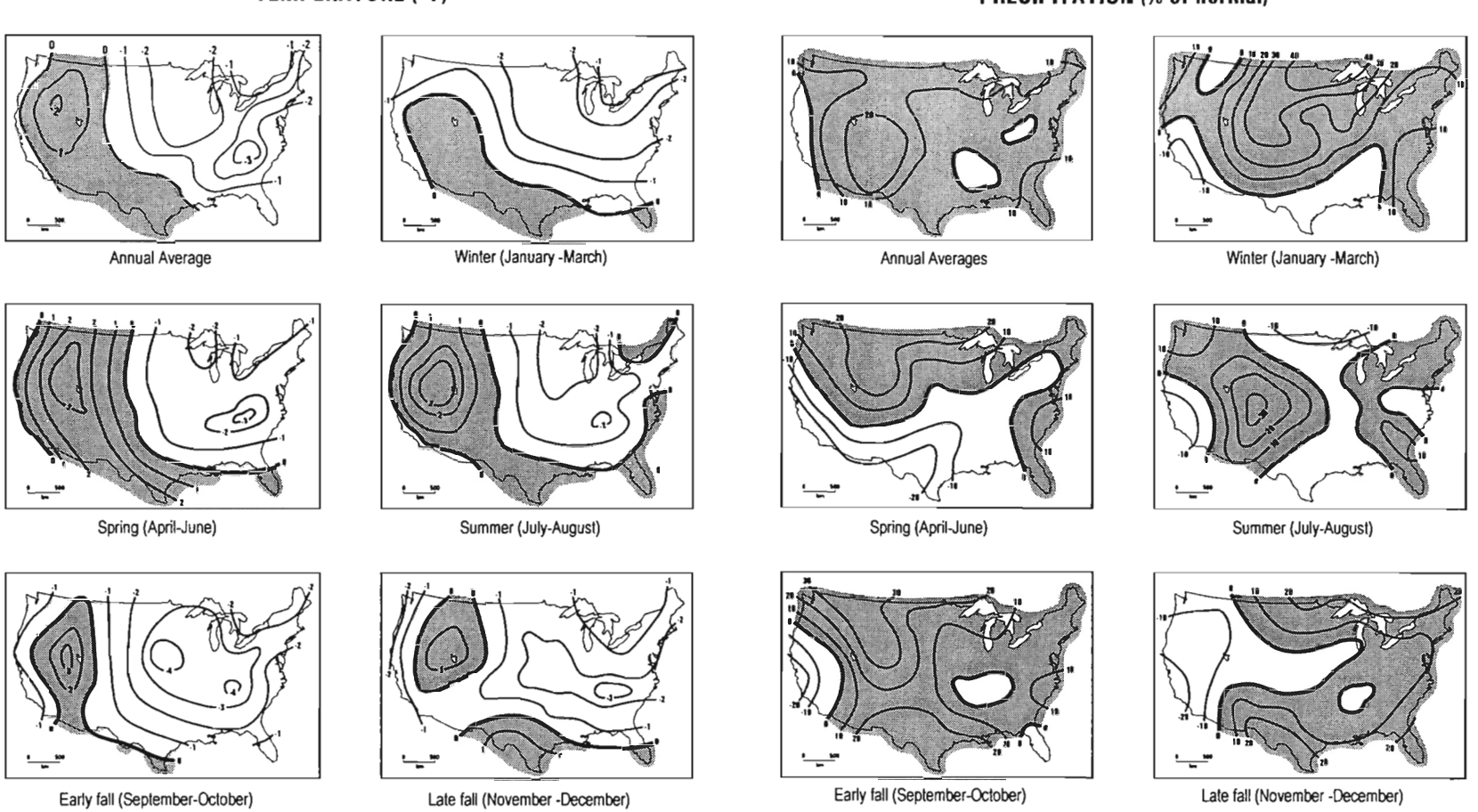

FIGURE 1: Deviations in 1850-1870 temperature (°F) and precipitation (%) from 1931-1960 normals, United States (modified from Wahl and Lawson,1970)

The median date of freezeup was 12 days earlier in the 19th Century than in the 20th and more importantly in the context of flooding, average breakup occurred 10 days later in the 19th Century; the period of ice cover was thus about 3 weeks longer in the last century.

A strong correlation between ice conditions and fall (October-November) and spring (March-April) temperatures suggests that temperatures in these seasons were, on average, 2.5°C colder in the 19th Century than in the 20th; the strongest correlation between ice condition and air temperature was for 19th Century March-April data. The change to "modern" conditions occurred rapidly at the end of the 19th Century, with the rapidity of change in breakup being the more pronounced. In the modern record, the latest ice-clearing date, April 26, occurred during the major flood of 1979. In contrast, this date was equalled or exceeded in 25% of the years in the 19th Century, and in 10% of the years, the river did not break up until early May. Rannie concluded:

> While the period 1861-1880 appears to have been particularly severe, breakup and freezeup data provide no indication of significantly milder temperatures, averaged over a period of a decade or more, during the entire century. The change in the fall and (early) spring climate at Winnipeg appears to have occurred relatively rapidly in the last years of the 19th Century. (Rannie, 1983, p. 295)

An almost identical pattern was obtained from a study of ice cover changes from 1855 to 1991 in Lake Mendota at Madison, Wisconsin (Robertson et al., 1992). Freezeup dates were 8 days earlier, breakup 8 days later, and ice cover 16 days longer before 1890 than since, corresponding to temperatures about 1-1.5°C cooler.

FROST DATA: First fall frost data tabulated from the daily record of minimum temperatures at Winnipeg from 1872 to 1988 indicate that the average date of first fall frost (at the 0°C threshold) occurred 10 days earlier in latter 19th Century than in the 20th (Rannie, 1990), with the change beginning within the first decade of the 20th Century. Mean annual minimum temperatures in August, September and October were about 1.5°C lower during the same period. A comparison of first fall frost dates for different frequencies before and after 1910 is given in Table 2.

TABLE 2
COMPARISON OF FIRST FALL FROST DATES AT SELECTED FREQUENCIES BEFORE AND AFTER 1910

Return Period	1872-1910	1911-1988
100 years	August 13	August 29
50 years	August 16	September 1
25 years	August 20	September 4
10 years	August 26	September 9
4 years	September 2	September 14
3 years	September 6	September 16
2 years	September 11	September 21

Archival documents from the Red River Settlement contain numerous references to August frosts which are difficult to reconcile with 20th Century climatic data but appear less unusual when the pre-1910 frost regime is recognized.

> August 19, 1832: This morning the air was excessively cold, a thick hoar frost covered the ground and the stagnant waters of the swamps were frozen...The potato tops are blasted. (Cochran, 1832)

> August 19, 1836: we were visited by a most destructive frost which destroyed the reward of the farmer...in wheat; it was truly a gloomy morning the whole of the vegetable world drooped and blackened as the sun grew warm, and (the air was filled with a most unpleasant odour...All garden seeds have been destroyed. (Jones, 1836)

Significantly, no change was detected in the date of last spring frost during the entire period from 1872 to 1988. This implies a lesser change in May-June temperatures as Wahl and Lawson (1970) noted (see above) and this, combined with later breakup, may suggest more rapid melt formation

TREE RINGS: Blasing and Fritts (1976) used tree-ring data to identify winter climatic anomalies in western North America from the 18th Century to 1966. Their reconstructions suggest that cold winter types were markedly more common in the 19th Century than in the 20th, particularly in the period 1820-1875. These were, of course, interspersed by warm winter types, notably in the decades 1810-20, 1830-40, and after 1875, but the overall frequency of these was lower in the 19th Century.

PRECIPITATION

Maps in Wahl and Lawson (1970) indicate that annual precipitation in the southern (US) portion of the Red River basin was somewhat greater (c. +10%) in 1850-1870 than in 1930-1960 (Figure 1). The largest seasonal difference was in winter (+40%), followed by fall and spring (+20%). Only in summer was 1850-70 precipitation lower (by 10%) than in 1930-60. Because of the large concentration of runoff in the spring snowmelt period, the increases in fall and particularly winter and spring are most significant in runoff generation.

Wahl and Lawson's data are for the mid-19th Century only, are highly generalized from a small data base, and as the authors point out, percentage changes in an area of small precipitation should be viewed with caution. Nevertheless, the pattern conforms well with other evidence and, if it were more generally true of the 19th Century than the 20 years discussed by Wahl and Lawson, would suggest higher runoff, in the spring at least.

An unusual feature of summer precipitation reported in archival materials is the incidence of summer high water and flooding caused by heavy rainfall. An especially extreme example in the summer of 1849 was chronicled in detail by Woods (1950) and

Pope (1950) on their expedition from Fort Snelling, Minnesota (modern day St. Paul) to Pembina in June-August, 1849. Selected extracts from their accounts are given in Table 3 and in more detail in Part B; the meteorological conditions in 1849 have been discussed by Blair and Rannie (1994) and Rannie and Blair (1995). Earlier studies by Parker (1964) and Lawson (1974, 1975) had noted the uncommonly cold early spring weather, late snowfall, heavy rainfall and swollen rivers on the Oregon Trail route taken by the gold rush migrants from the vicinity of St. Louis to California. From Woods' and Pope's accounts, and descriptions by people in the Red River Settlement, it is apparent that these unusual conditions extended northward into the Red River Valley. Blair and Rannie (1994) noted that breakup of the Red at Winnipeg did not occur until the first week of May, heavy rainfall in the south-central Great Plains occurred in May, July and August, and the Red River Valley region received exceptional rainfall from June until the third week of August. Mean April, May, July and August temperatures were below-average (compared with 19th Century local normals) at stations as far apart as Fort Snelling and Norway House; total precipitation at Fort Snelling from April to August was about double the 1837-1855 average and has not been exceeded in the Minneapolis-St. Paul region since. The descriptions of river conditions by Woods and Pope indicate very large runoff in all streams along their route. A measure of the severity of the event is the state of the Red River at Pembina. As early as June 17, Father Belcourt at Pembina wrote:

> The water of the river, which is rising rapidly, makes us fearful; a part of the seed put in the low ground is going to be ruined. (Belcourt, 1849)

Later accounts by Provencher and Pope confirmed these high waters:

> The water is extraordinarily high...all the rivers are inundated. they say that Pembina is drowned and it is believable from the height of the water here. there is already grain in the water and it doesn't appear to have decided to lower yet...it rains often and without doubt much more copiously upstream than here. (Provencher, 1849b)

> When the expedition first reached Pembina the incessant rains for weeks previous had caused all the rivers to overflow their banks; but when I embarked to ascend the Red River [beginning his southward journey on August 26], it had subsided into its usual channel. (Pope, 1850, p. 34).

The similarity of these conditions to the extreme summer rainfall of 1958 and 1993 has been discussed by Blair and Rannie (1994) and Rannie and Blair (1995) and the possible synoptic conditions which produced the event will be discussed below.

The 1849 event might be regarded as a rare, random occurrence of little general significance except that similar conditions appear to have occurred in a number of other years as well, some examples of which are given in Table 3 and others are described in Part B. One of the most notable was in 1806 when the prairies were exceptionally wet throughout the entire summer and the Red appears to have exceeded bankfull stage at Pembina at least.

Summer floods on the Red River, while not unknown (eg. 1975), are very uncommon and inconsequential in magnitude. The modern probability of bankfull stage occurring in the summer is less than 1% and even as extreme a precipitation regime as occurred in 1993 did not produce bankfull stage as far downstream as Pembina. The possibility that several such events occurred within a 60-year period suggests that the summer synoptic conditions of the region were different from modern conditions in a significant number of years and that "excessive" precipitation (by modern standards) may have been more common.

The summer of 1855 also seems to have been one of exceptional rainfall, although there is no indication that the Red River was overbank, or even bankfull. Donald Gunn recorded a remarkable 39.75 inches (1010 mm) of rain from June to September at Lower Fort Garry (United States Patent Office, 1861), an amount that might be dismissed as a product of poor measurement or transcription error except that Gunn was an accredited Smithsonian observer, the report did not indicate that the record was doubtful (for which there was provision) and finally, similarly heavy August rainfall (10.5 inches) was also recorded at Lac qui Parle in southern Minnesota (compared with 13.5 inches at Fort Garry; July and September data were not given).

ATMOSPHERIC CIRCULATION

The remarkably wet summer of 1849 and others which produced high summer streamflow or flooding (Table 3 and Part B) are reminiscent of the extreme precipitation in the summer of 1993 which resulted in high water throughout the north-central Great Plains (including the Red River basin) and record flooding on the Mississippi. Kunkel et al. (1994) showed that large-scale atmospheric circulation patterns during extreme rainfall events in this region are associated with a longitudinal shift in the normal pressure patterns such that the typical pattern of pressure anomalies in North America was reversed. The normal ridging in the northern Great Plains-Midwest region, which Harmon (1991) described as "the most prominent [summer] feature in the Northern Hemisphere" (p.55), was replaced by a trough during these events, producing an abnormally strong flow of moist subtropical air from the Gulf of Mexico. Blair and Rannie (1994) and Rannie and Blair (1995) showed that almost identical conditions occurred in 1958, another extremely wet summer.

Interestingly, Fritts et al. (1981) found a similar pattern of pressure anomalies in 1849, reconstructed from tree rings in the western United States. Rannie and Blair (1995) concluded that the apparently greater frequency of extreme summer precipitation in the 19th Century indicates that

> ...the type of atmospheric circulation observed in July 1958 and 1993 may have been more common in the nineteenth century than would have be inferred from twentieth-century instrumental records. (Rannie and Blair, 1995, p. 199)

TABLE 3
SELECTED HISTORICAL ACCOUNTS OF EXCEPTIONALLY WET SUMMERS IN THE RED RIVER BASIN

1806	June 26	Water extraordinarily high (on the Red River) and continued storms which breed an incredible number of mosquitoes. (Alexander Henry in Coues, 1965, p. 281)
	July 7	The travelling was tedious from the heavy rains...In many places we found several feet of water; every little hollow formed a pond and every rivulet appeared like a river. Our horses often sunk up to their bellies...The water (on the Red River) was very high...They attempted to go (to the east side of the Red) but found the country almost entirely overflowed. (ibid, p. 285-6)
	August 13	This summer's extraordinary rain, having overflowed the low country, has caused the buffalo to move to the high lands southward. (ibid, p. 420)
	August 14	We found a great quantity of water, and for a long distance our horses had it up to their bellies...This road used to be firm and good but the continued rain of the summer has altered the face of almost everything, and there is now mud and water knee deep. (ibid, p. 421)
1825	June 21	Very few fish have been caught this season in the River, owing to the unusual height of the waters; nor can any improvement be expected in the way of fishing, until the floods abate. (Red River Journal, HBCA, B.235/a/6 1824/1825)
	July 30	...we are not as yet able to get the rafts unloaded the beach being still covered with twelve feet water. (ibid)
1827	Sept. 20	Not a day passes without heavy rains...The Rivers are greatly swollen by the late rains, as much so, as after the ice went off in the spring and it is even a difficult matter to go on horseback from one end of the Settlement to the other, the face of the country is so entirely covered with water. (Red River Journal, HBCA B.235/a/8 1826/27)
1849	June 6	the rains commencing on the 4th continued intermittingly until...the 11th...The rains having fallen so steadily and for so many days, the earth was so saturated with water, that the thickly-matted turf of the prairie would not support the weight of the wagons...The (Sauk River) was much swollen by the heavy rains and was wide and deep. (Woods, 1850, p. 11)
	June 27	The heavy and incessant rain since the 4th of June had so saturated the prairies...that it was found necessary to halt for a few days...many were under the impression that the whole country was swampy, but I was informed by the guides that such a season had not been known for twenty years, and that they had never seen the country in such condition before. (Pope, 1850, pp. 18-19)
	July 6	The prairies were so bad from the drenching rains that had just fallen (that) we were scarcely able to get along. Little drains that usually contain no water, were now almost swimming...(Woods, 1850, pp. 13-14)
	August 8	...the ground was one swamp with the incessant rains. (James, 1849, at Red River Settlement)
	August 28	...the water has been so high all summer that there is no way to communicate with Pembina except by water...(at M. Belcourt's post at Pembina)...the water covered the fields. (Provencher, 1849)
1851	July 15	Already for 15 days it has been raining, the water rises and rises. (Provencher, 1851a)
	July 21	The abundant rain has done damage to the grain. The water rises continually and could destroy the crop on the low ground. (Provencher, 1851b)

Other writers have suggested that enhanced meridional circulation (which would be the consequence of the pressure pattern described above) was a more prominent feature of the Little Ice Age atmosphere. For example, Bryson (1980) concluded that the

> development of the north-south meandering of the high altitude westerly winds...[was] far more common during the Little Ice Age than in the twentieth century...By the time the wave of European emigrants reached the Great Plains in the nineteenth century, conditions had changed from those that had characterized the thirteenth and fourteenth centuries. Instead of the drought that had terminated corn agriculture over a wide area, the Great Plains had up to 30 percent more rainfall than in the modern era...The rainier, cooler climate on the plains supported a "sea of grass" which, in turn, supported the enormous herds of bison. (Bryson, 1980, p. 72).

Knox (1983) considered the effects of such a circulation change on flood magnitudes, using as an example the record for the upper Mississippi River basin at St. Paul. This basin is adjacent to the upper Red River basin and because of its relevance in the present context, it is worth citing at length.

> Contrary to a common assumption that the probability of a flood of a given magnitude remains constant over time, many long historical records reveal clustering, especially of large floods... This tendency reflects the fact that floods are associated with large-scale upper atmospheric regimes with westerly circulations. During periods when westerly circulation is weak and meridional regimes prevail, polar air masses often extend to low latitudes and tropical air masses often extend to high latitudes. Such extreme latitudinal ranges frequently result in the development of intense cyclones and storms in the middle latitudes that are followed by large floods. During periods when zonal regimes prevail, a strong westerly flow predominates and intense cyclones and storms are less likely. Hence, most areas of the United States that are relatively far removed from sources of moisture tend to become drier and experience fewer large floods during periods of zonal dominance. An example is the historical record of Mississippi River floods at St. Paul, Minnesota...[reproduced as Figure 2 in this report]. The record of all floods exceeding a discharge of 368 m^3 per second is partitioned into four categories defined by changes in the dominant patterns of large-scale atmospheric circulation... In general, meridional pattern[s] are more dominant during the flood-episodes represented by the pre-1896 and post-1949 categories. Zonal patterns are shown to have been more dominant during the intervening years. [Figure 2] shows that high-frequency, low-magnitude floods differ little among the four climatically defined episodes but that low-frequency, high-magnitude floods are considerably different. Thus, over longer time spans, such as the Holocene, the recurrence intervals of floods of a given magnitude probably have changed dramatically in response to changes in prevailing patterns of atmospheric circulation over various regions of the United States. (Knox, 1983, p. 29)

Miller and Frink (1984) compared flood frequency curves for the Red River at Grand Forks for 4 sample periods: 1882-1904, 1905-1929, 1930-1954, and 1955-1979 (Figure 3). Although these time periods differ somewhat from those used by Knox on the upper Mississippi, they display a similar pattern. Two aspects stand out: the sharp change between the curves for 1882-1904 and 1905-1929, and the apparent return toward 1882-1904 conditions after 1955. It is noteworthy that both Knox (1983) and Miller and Frink (1984) found that the magnitude of low-frequency events after 1949-55 (the period of increased frequency of serious floods in the Red River valley) more closely approx imated the late 19th Century values. Miller and Frink concluded

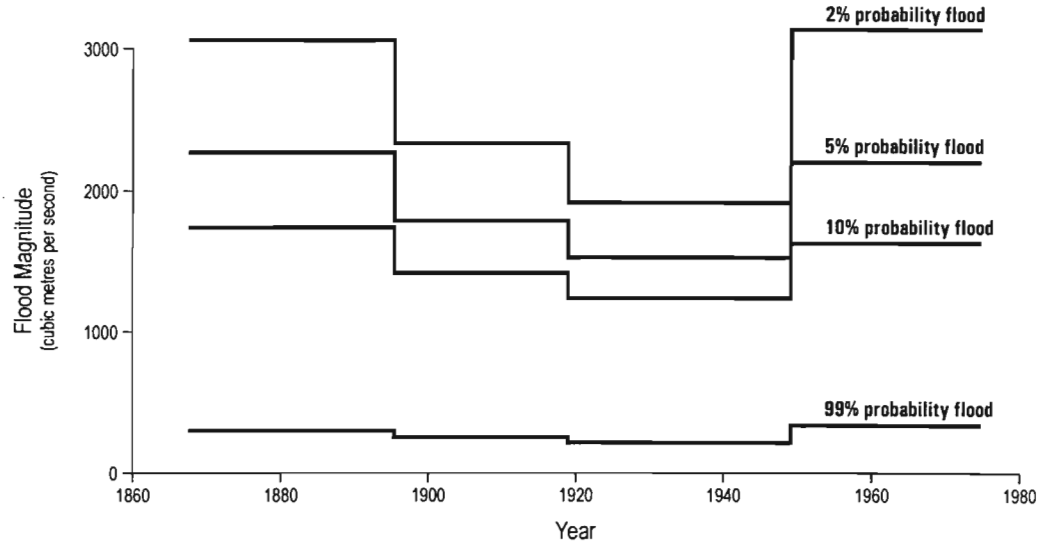

FIGURE 2: Flood magnitude at selected frequencies and time periods, 1865-1975, Mississippi River at St. Paul (redrawn from Knox, 1983)

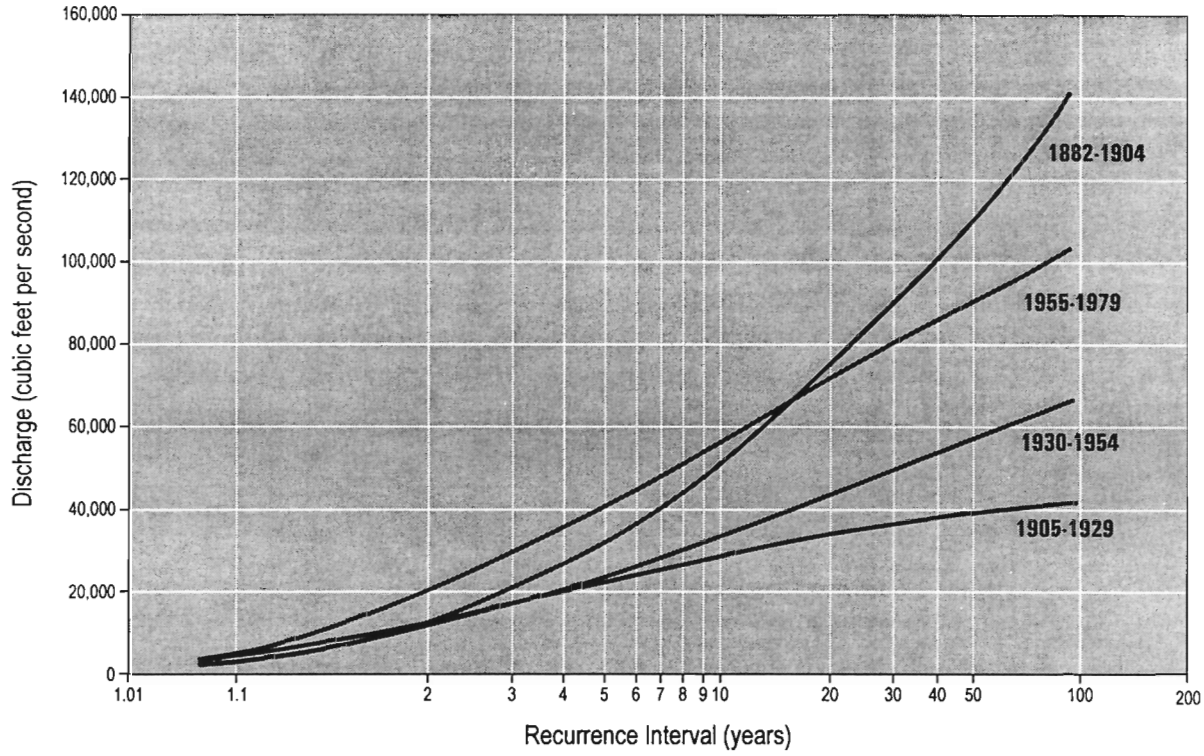

FIGURE 3: Flood frequency curves for selected time periods, Red River at Grand Forks (redrawn from Miller and Frink, 1984)

> The flood-flow characteristics of the late 1800's appear to be similar to those for the period since about 1950 or 1960. The period between approximately 1910 and 1950 is not similar to either of the early or late periods... (Miller and Frink, 1984, p. 35)

Others have found a distinct change in the dominant circulation patterns about 1950. For example, Kalnicky (1974) observed

> ...meridional circulation patterns have become more prevalent in both winter and summer since the early 1950's, and zonal circulation patterns have occurred less frequently...The abrupt transition from a relatively stable zonal circulation before 1950 to a predominantly meridional circulation afterwards appears to support a step function of climatic change. (Kalnicky, 1974, pp. 111-112)

It should not be concluded that wet summers (and meridional circulation) were the norm in the 19th century but their frequency seems to have been greater than in the 20th.

EFFECTIVE MOISTURE AND RUNOFF

Averaged over a period of years (to eliminate the significance of storage changes), annual runoff is the simple difference between annual precipitation inputs over the watershed and losses by evapotranspiration. Thus, it integrates the climatic effects of changes in both. According to Stockton (1990),

> runoff has special merit as an indicator of climate in that its response is proportionally (approximately 3-fold) greater to climate change than is that of precipitation alone. (Stockton, 1990, p. 176)

Zalsberg (1990) estimated the effects of a number of climate change scenarios on runoff from Wilson Creek Manitoba, using both long-term annual (Thornthwaite) water balance and (Langbein) graphical methodologies. For a cooler/wetter climate scenario (-2°C decrease in mean annual temperature and 20% increase in precipitation), his results indicated a 79-90% increase in mean annual runoff; for a -2°C change and a 10% increase in mean annual precipitation, the increases in runoff were smaller but still dramatic (+57 to 61%). Stockton and Boggess (cited by Zalsberg) obtained similar results (+68%) for the Souris-Red-Rainy River region for a -2°C/+10% scenario. According to Zalsberg, such increases in runoff would be accompanied by

> (1) a decrease in annual streamflow variability;
> (2) some increase in streamflow persistence;
> (3) an increase in high flow periods and high floods (Zalsberg, 1990, p. 341)

These scenarios are representative of the temperature and precipitation differences which have been suggested for the Little Ice Age and are comparable with those indicated by Wahl and Lawson (1970) for the Red River basin region in 1850-70.

Miller and Frink (1984) performed a double-mass analysis comparing cumulative

peak discharges of the Red River at Grand Forks and the Mississippi River at St. Paul (1882-1980). Their figure shows a strong change in slope in 1908 such that after that date, relative magnitude of peak discharge of the Red decreased with respect to the Mississippi (Figure 4). They concluded

> Because there is no known reason for a response change following 1908, this is probably a spurious break caused by the inherent variability in the hydrologic data. (Miller and Frink, 1984, p. 35).

Given the climatic change that appears to have occurred in the region of the Red River basin about the turn of the century, alternative conclusions might have been that (a) the climatic change was less in the Mississippi basin, or (b) the considerable differences in the surface condition of the two basins (particularly vegetative cover, topography, and lake area) produced a different response to the same climatic change), or (c) the Red River is in general more sensitive to climatic change than the upper Mississippi, as was suggested above, or (d) some combination of (a), (b) and (c).

DEVIL'S LAKE: An independent indicator of runoff is provided by changes in the levels of Devil's Lake, a 9,870 km^2 closed drainage basin within the western Red River watershed. Because it does not lose water by outflow, the level of the lake is a reflection of the climatic water budget within the basin, i.e. it records the balance between inputs (runoff from the surrounding basin + precipitation on the lake surface) minus losses (evaporation from the lake surface) and thus is proportional to "effective precipitation".

The fluctuations in Devils' Lake elevations from the first surveyed level in 1867 to February, 1997, are given in Figure 5 (Wiche et al., 1997). From the maximum of 438.4 meters above sea level in 1867, the lake level fell almost continuously to a minimum of 427.1 in 1940; from 1940 onward, the level fluctuated upward, recovering virtually all of the post-1867 loss. Levels prior to 1867 cannot be known with certainty. Based on a tree-ring chronology, Upham (1895) inferred that the lake level had been 439.2 in 1830, somewhat higher than in 1867. Based on diatom and sediment analysis of three cores from Devil's Lake and inferred salinity, Fritz et al. (1994) argued that lake levels were lower than at present from about 1500 to 1850 and that effective moisture was substantially smaller during the first half of the 19th Century. Conversely, Wiche et al. (1996, 1997) have argued that lake levels were generally (although not necessarily continuously) higher from 1800 to 1870 than since 1870, implying that effective precipitation was generally greater during the majority of the 19th Century prior to about 1870.

The balance of evidence, including many of the studies referred to elsewhere in this section, appears to support the latter interpretation. For example, Laird et al. (1996) used diatom assemblages to reconstruct a 2,300-year salinity and drought intensity

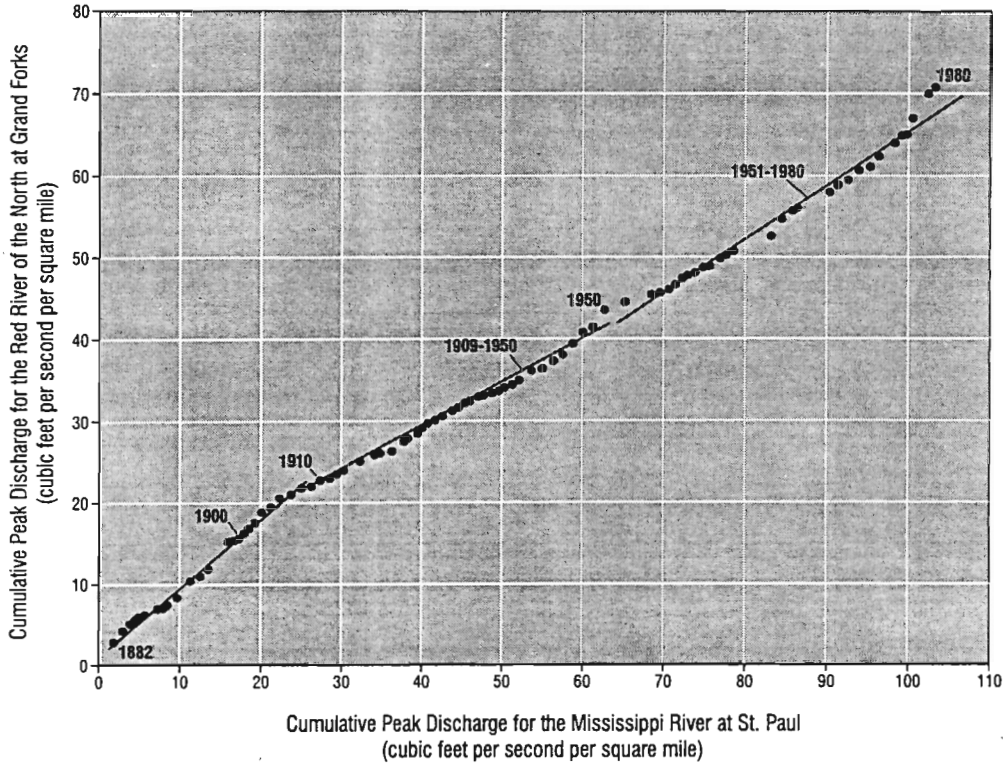

FIGURE 4: Double-mass analysis, peak flows, Red River at Grand Forks vs. Mississippi River at St. Paul,1882-1980 (redrawn from Miller and Frink, 1984)

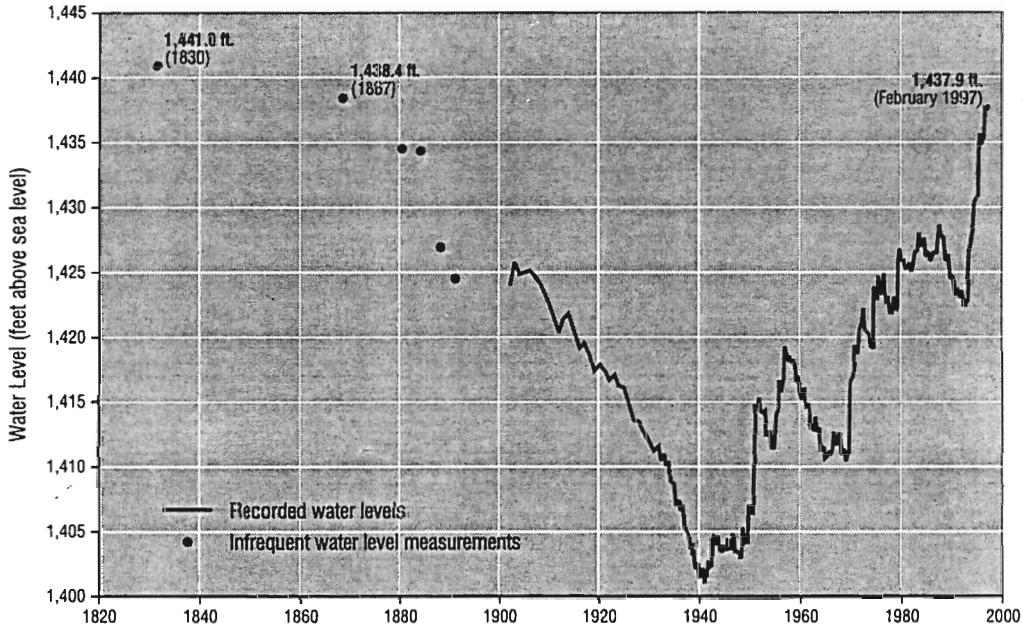

FIGURE 5: Water levels for Devil's Lake, 1830-1997 (redrawn from Wiche et al, 1997)

record for Moon Lake, North Dakota (about 135 km SSE of Devil's Lake). In contrast to Fritz et al. (1994), their data indicate that the period 1800-1850 had the lowest absolute and average salinity in the entire record, including a

> freshwater interval (salinity <3 g/l) during AD 1820-35 (which) corresponds to both an episode of abruptly cold temperatures frequent in many records in the early to mid-1800's, and to a drought-free period from 1825 to 1838 inferred from tree-ring records on the periphery of the US Great Plains. (Laird et al., 1996, p. 553)

Vecchia and Wiche (1997) used a mass-balance model and modern hydrologic data to generate 200 artificial lake-level sequences (constrained by known lake levels). From these, it was possible to place probabilities on possible ranges in lake levels for the period 1826-1890. They concluded

> ...the most likely scenario is normal (compared to more recent data) precipitation and inflow in the 1830's, 1840's and 1870's, above normal inflow in the 1850's and 1860's, and below-normal precipitation and inflow in the 1880's. (Vecchia and Wiche, 1997, p. 44)

Wiche (1986) reviewed other data for closed basins in western Canada and United States. Although most of the examples he cited are from the 20th Century, they display the same general patterns as Devil's Lake. Particularly relevant here is the example of Big Marine Lake in Minnesota which appears to have been about 20% larger in area in 1847 than in 1982 (2300 acres vs 1900 acres).

Comparison of the long-term records of levels of Devil's Lake and the smoothed runoff for the Red River basin (at Grand Forks) shows them to be strongly synchronous (Figure 6), suggesting that Devil's Lake levels provide an index of runoff conditions in the Red River basin as a whole. If, as was argued above, Devil's Lake had generally higher levels during most of the 19th Century, it would follow that runoff was probably also higher. Stockton (1990) noted the broad similarity of patterns not only between the Red River and Devil's Lake but of the Mississippi River at St. Paul, Lake Superior outflow at Sault Ste. Marie, and the levels of Great Salt Lake as well, suggesting a similarity of runoff response over a broad regional band of North America between latitude 32°N and 45°N.

DROUGHTS:

Although the archival records contain numerous references to droughts and low water conditions during the 19th Century, there has been no systematic study of their frequency or character. Accounts of one of the most severe individual events, from the late winter of 1804 to the fall of 1805, however, have been analyzed by Kemp (1982). Extreme drought was reported over an area from the Missouri River region of North Dakota eastward to Lake Nipigon. Kemp tentatively suggested that this drought was caused by persistent high pressure over the region which diverted low pressure systems north of their normal path.

Despite the 1804-1805 drought and some other dry episodes which are identified in PART C of this report, there is evidence that much of the 19th Century experienced relatively fewer droughts than the subsequent 20th Century.

Tree rings are commonly used to infer drought history prior to instrumental records. In an early study, Will (1946) used sections of burr oak collected near Bismarck, North Dakota, to characterize annual precipitation from 1406 to 1940 as wet, average, or dry. From 1786 to 1876, wet years outnumbered dry years by a ratio of 2:1; during the period of declining levels of Devil's Lake, from 1877 to 1940, this ratio was reversed, i.e. dry years outnumbered wet years by a ratio of about 2:1. Will's graphs indicate two major periods of protracted dry years prior to 1876: 1802-1809 and 1836-1851. Will's methodology was relatively unsophisticated and more subjective than subsequent dendroclimatological studies. A more recent drought reconstruction from tree-rings in other Great Plains regions by Stockton and Meko (1983) suggests that droughts were relatively infrequent from 1800 to 1860 and that the period 1825 to 1838 was almost drought-free.

> Stretches of 10 or more years without drought in any of the regions occurred once or twice per century (from 1700). The most striking of these periods occurred from 1825 to 1838, immediately after the extreme drought of the early 1820's. (Stockton and Meko, 1983, p. 22)

During most of this period, their figures indicate above-average precipitation over a broad region of the Great Plains.

Both of these studies cover drier regions outside of the Red River basin (considerably so in the case of Stockton and Meko) and it might be argued that they are not representative of the conditions within the basin. The general thrust of their conclusions, however, is supported by other studies. For example, this period coincides with the "freshwater" and high effective moisture interval found by Laird et al. (1996) in their study of Moon Lake referred to above. Clark (1988) used the charcoal content in annually laminated sediments to derive a 750-year record of forest fire regimes in Lake Itasca Park, northwestern Minnesota. His graph indicates that after a substantial peak in the latter 18th Century, most of the 19th Century (until about 1880) had a low 'charcoal index', suggesting low fire frequency and presumably more consistently 'moist' conditions.

FIRE HISTORY: Several centuries of forest fire history have been reconstructed for two areas of northern Minnesota. In Itasca State Park of northwestern Minnesota (adjacent to the southeastern Red River basin), Frissell (1973) and Clark (1990) identified major fire episodes in 1802-05, 1811-14, 1820, and 1863-64. Further to the northeast in the Boundary Waters Canoe Area east of Lake of the Woods, large fires occurred in 1801, 1815, 1822, 1854, and 1863-64 (Heinselman, 1973; Swain, 1973). In each area, the 1863-64 fires were the largest in the period from 1790 to 1870 and were among the largest in the last 3 centuries. The factors which govern the occurrence of forest fires

are complex but they include a strong climatic component, in particular spring and fall drought. As will be discussed in PART C, the period 1800-1820 was marked by periodic low runoff in the Red River (particularly 1803-05) and the exceptional 1863-64 fires coincided with intensive drought and very low runoff. From the fire history in Itasca and varve thickness and charcoal accumulation in local lakes mentioned above, Clark (1988) concluded that the frequent fires from 1770-1820 indicated periodic warm/dry conditions and that the interval 1820 to 1863-64 was cool and moist.

EVAPOTRANSPIRATION

In attempting to explain the similarities among runoff patterns in Devil's Lake, Great Salt Lake, Lake Superior, Red River and upper Mississippi River, Stockton (1990) argued for greater consideration of the role of potential evapotranspiration:

> Up until the promising work of Charney (1975), Cess (1978) and others, it went unchallenged in the view of most researchers in water resources that potential evapotranspiration (PET) proceeded at some nearly constant rate through time. Little research effort has been accorded to this complex variable because of this basic assumption and most probably its known complex nature. However, recently while working in Morocco, we became aware that PET may indeed vary in monthly and seasonal amounts by as much as 2 to 3 times...Whether such dramatic variations are unique to the geographic and climatological nature is unclear, but they do sound an alert to the effect that temporal non-variation in PET should not be routinely assumed. In fact it is my contention that the entire area of evapotranspiration and its influence in regional climatic variability is possibly one of the most misunderstood of all climatic elements and should be an area of intense and considerable climatic research in the next decade. Such integrated measures of climate as runoff, lake levels, tree-ring series and others, may possibly reflect climatic variability due to temporal changes in evapotranspiration which have not been sufficiently recognized. (Stockton, 1990, p. 177)

There is reason to suspect that variations in evapotranspiration may play a role in producing variations in runoff in the Red River basin. The Runoff Ratio (runoff÷precipitation) is very low, generally only 3-7% except in large flood years. Stated in reverse, evapotranspiration (ET) accounts for 93-97% of precipitation and even small variations in ET would produce substantial variations in runoff, even in the absence of any change in precipitation, and conversely, a much larger change in precipitation would be required to produce a substantial change in runoff if PET were constant.

In reality, it is likely that both might vary in a mutually-reinforcing fashion, i.e. there is a broad tendancy for warm periods to have less precipitation (hence warm-dry) and cool periods to have greater precipitation (cool-wet). A demonstration of this is given in Figure 6 using data from Longley (1977). Longley computed 10-year running means for growing season (May-September) mean temperatures at Winnipeg and precipitation in the Red River basin. If the scale for temperature is inverted to reflect smaller potential or actual evapotranspiration (and thus potentially greater runoff) at lower temperatures, the variations in the two time series are remarkably similar. The 10-year

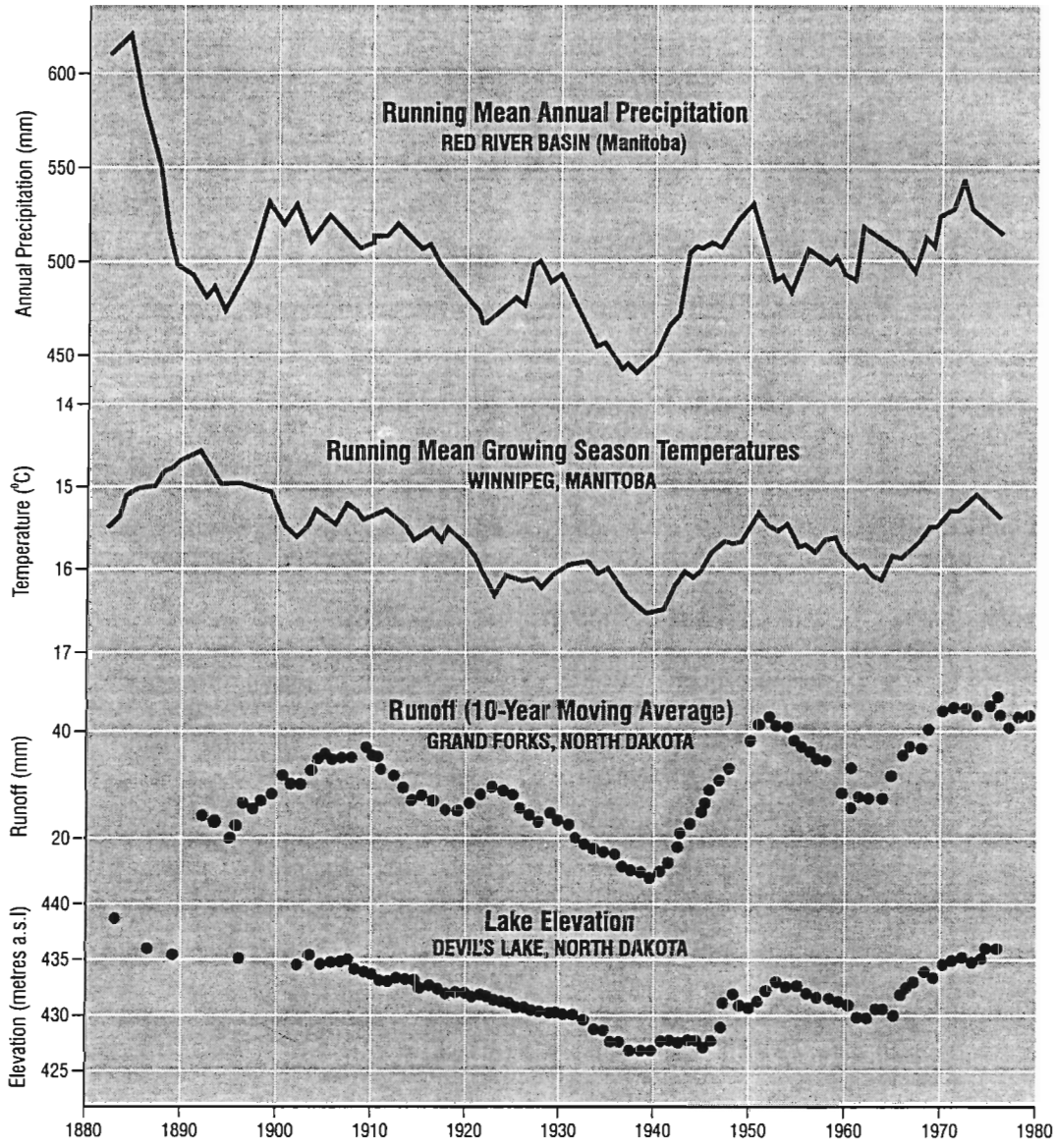

FIGURE 6: Smoothed time series of precipitation and growing season temperature (redrawn from Longley, 1977), water-year runoff at Grand Forks, and Devil's Lake elevation

running mean for runoff at Grand Forks and the levels of Devil's Lake show almost identical patterns. Thus, a cool-wet episode such as the Little Ice Age has the potential for substantially increased runoff in comparison with the warmer, drier 20th Century. In Zalsberg's study described above, a -2°C/+10% precipitation change resulted in c.60% increase in runoff. It is largely for this reason that the eastern Prairies have the hydrologic sensitivity to climatic change noted by Ashmore and Church and Knox above.

Clark (1989) examined the effects of variations in Thornthwaite water-balance on the fire regime in Itasca State Park, Minnesota, from 1840 to 1980, using temperature and precipitation data for Minneapolis. He concluded

> The generally lower temperatures (and thus reduced evapotranspiration) and the higher precipitation of the Nineteenth century relative to the Twentieth...resulted in a shift from a strongly positive water balance in the Nineteenth century to one characterized by roughly equivalent precipitation and potential evapotranspiration during the Twentieth...Five-year running means of effective precipitation (P-ET°) were negative in the 1850's, 1890's and much of the Twentieth century. (Clark, 1989, p.996)

Examination of his time series for effective precipitation (P-PET) indicates that the negative 5-year running means he found for the early 1850's were an aberration caused by exceptional dryness and above average temperatures in a single year, 1852. In that year, total precipitation was the second lowest in the entire 144-year record and in the summer (June-September) period when negative water-balances are generated, precipitation was less than one-third of normal. There is no indication that this exceptional drought was experienced in the Red River basin and it is likely that water-balances were positive in that decade as well. The generally positive water-balances Clark found for the 19th Century were principally caused by greater precipitation but 15-year running means of evapotranspiration rose by 12-15% from the mid-19th to the late 20th Century.

CHANGES IN LAND COVER AND DRAINAGE:

A complicating, and controversial, factor in any hydrological assessment is the change that has occurred in the land cover and drainage within the watershed. The original native grassland and forest throughout the central and eastern regions have been replaced by agricultural uses, most of which leave the land surface bare during the spring runoff period. Much of the original land surface consisted of wetlands, either as extensive swamps (Figure 7) or as smaller individual depressions, sloughs, and "potholes". From the turn of the century, massive drainage schemes have eliminated virtually all of the larger swamplands and drained a great many of the smaller closed depressions. North Dakota and Minnesota wetlands have been reduced by almost 50% in the last two centuries, from an estimated 81,000 km^2 in the 1780's to 45,000 km^2 in the 1980's (Dahl, 1990). Most of this loss came in the Red River valley region of North Dakota and Minnesota and the Manitoba portions of the watershed experienced

Dakota and Minnesota and the Manitoba portions of the watershed experienced similar loss of wetland.

The hydrological consequences of this massive conversion are complex, poorly understood, and in fact, little studied. Moreover, the subject itself is controversial. A detailed review is beyond the scope of this report but some observations are appropriate. The progressive integration of previously closed drainage into the stream systems tributary to the Red constitutes an increase in effective drainage area. Other areas which may have been integrated into the original drainage, even if only seasonally, provided temporary storage which would have delayed runoff and inhibited flood formation, an effect which would no longer be available after drainage. The artificial drainage systems served a twofold purpose: to increase the area of arable land and to remove surface water more rapidly in the spring, both of which would increase the runoff ratio in comparison with the natural landscape. In addition, because the gradients toward the river are greater than the downstream gradient of the Red River itself, it is likely that water is delivered to the main river more quickly than it can be removed.

Moore and Larson (1979) conducted a modelling study to determine the effects of drainage on streamflow in small watersheds tributary to the Minnesota River. Among their conclusions were the following:

> Surface drainage of depressional areas within the watershed significantly increased annual runoff, storm runoff volume and peak discharges...Enlarging and straightening main channels significantly increased peak discharges by causing the water to be discharged in a shorter time. The effect of main channel improvement on peak flow was more significant than the effect of draining individual depressions...Drainage had a lesser effect on the peak flows from short duration, high intensity storms than from long duration, low intensity storms and snowmelt. (Moore and Larson, 1979, p.135)

They found little effect of drainage development on the master stream, the Minnesota River, a contrary fact they attributed to the downstream attenuation of increased tributary inputs. This latter conclusion would probably not apply in the Red, however, since drainage ditches feed water into the Red along virtually its entire length.

Brun et al. (1981) examined the effects of land drainage on the Maple and Goose Rivers, western tributaries of the Red River in North Dakota, both of which displayed increases in mean annual, maximum daily, and mean spring discharge over several decades prior to September, 1979. They found that land drainage had increased contributing area by 64% in the Maple River watershed and by 180% on the Goose River, and their regression analysis showed:

> ...the increase in predicted flow is strongly related to increase in drainage area in each basin... The analysis indicates that approximately 50 per cent of the increase in predicted mean annual flow, 36 per cent of the increase in predicted maximum daily flow, and 70 per cent of the increase in predicted mean spring flow is due to increased drainage area. (p. 13).

They concluded:

> Significant increases in flow on the Maple, Wild Rice and Goose Rivers have occurred over the last 30 to 40 years. Flow rates were shown to be related to climate (precipitation); however, there appears to be no change in precipitation patterns to account for the increase in flow rates. Predicted flow rates were shown to be closely related to changes in basin size due to land drainage in the Maple and Goose River basins. It appears that land drainage is a factor aggravating the flooding problem in eastern North Dakota... (p. 14).

The natural cover of native grasses and woodlands may have maintained greater infiltration, reduced soil evaporation, increased soil moisture status, and trapped more snow, in comparison with the agricultural cover of the late 19th and 20th Centuries. Thus, the conversion of grassland to an agricultural land cover which is mostly bare during spring runoff may have further increased the rapidity of runoff formation and the runoff ratio (eg. Glymph and Holtan, 1969). More recent agricultural practices such as summer fallow and minimum tillage reduce soil moisture loss and, in effect, replicate some of the hydrologic characteristics of the pre-agricultural vegetation cover.

These factors confound comparison of hydrologic conditions in the 19th and 20th Centuries and raise the question of what 19th Century runoff and flood magnitudes might have been had they occurred on a 20th Century landscape.

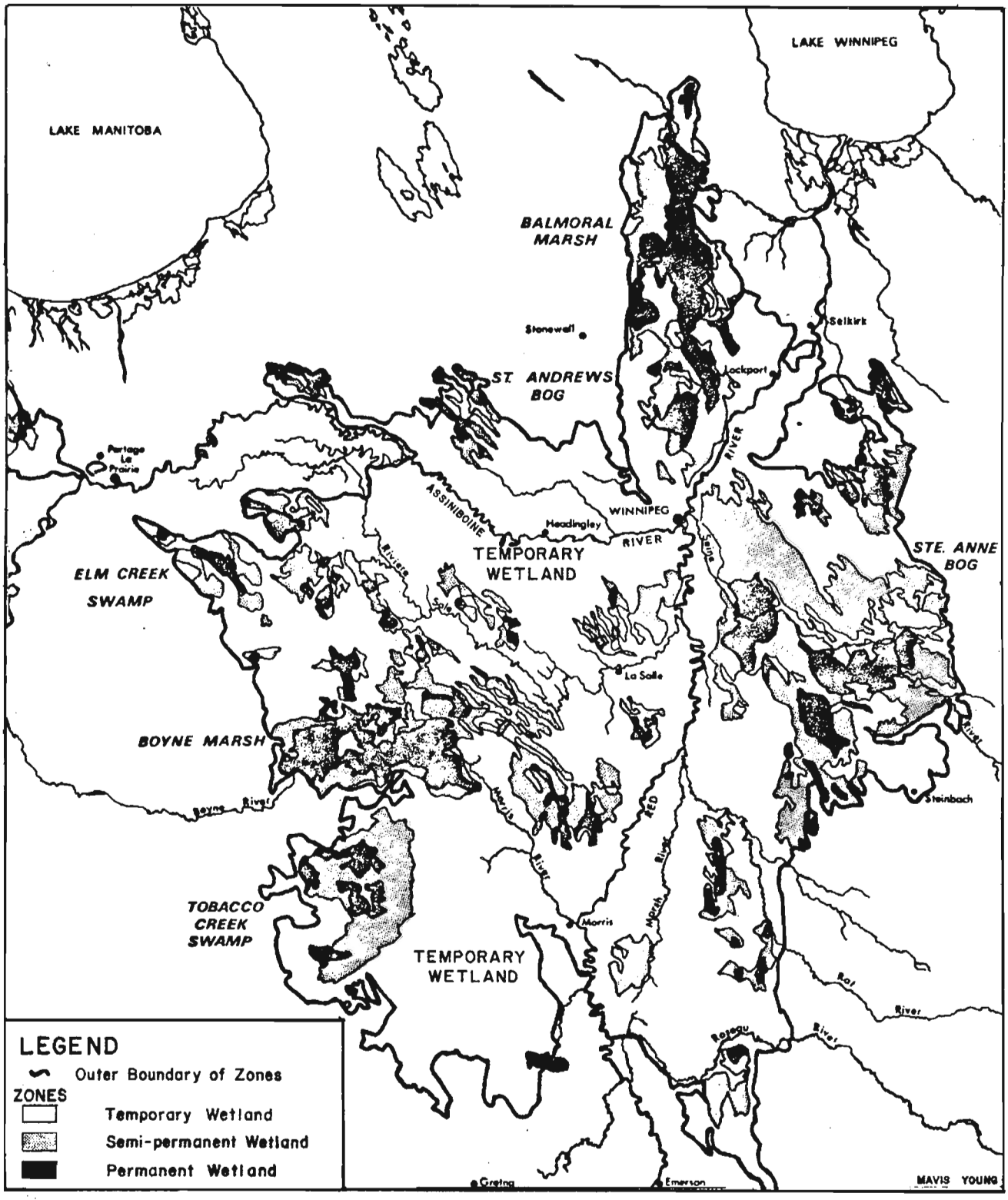

FIGURE 7: Original wetlands of the Red River Valley.

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PART B

FLOODS AND HIGH WATER EVENTS RED AND ASSINIBOINE RIVERS, 1793-1870

INTRODUCTION

In this section, archival reports of floods or high water conditions for the Red and Assiniboine Rivers are reviewed. All events which appear to have reached bankfull conditions or greater along some reach of either river have been included, regardless of whether serious flooding is indicated, to ensure that no possible floods have been overlooked. For comparison, the most complete existing list of historic floods (Miller and Frink, 1984) is reproduced in Table 4.

Clearly the events discussed in this section represent an enormous range of discharges, from those which are simply above-average but of no long-term importance, to floods of great magnitude. The events on the Assiniboine are included because they have generally been neglected in other historical studies, despite their potential to generate significant amounts of runoff during extreme events. The contribution of the Assiniboine becomes particularly relevant in evaluating the relative severity of the 1997 flood.

For each event, the rivers involved (Red or Assiniboine) and the season of the year (spring or summer) are listed. As in the modern record, most floods of consequence in the 19th Century occurred in the spring, but some significant summer events seem to have occurred as well. Because summer floods are unusual in comparison with the flow regime during most of the 20th Century, they are especially interesting, although probably not among the largest 19th Century events..

The entries begin with a chronological description of the event, using the original accounts. Antecedent conditions are also described, beginning with the previous autumn and freezeup period and extending through the winter to the breakup period or the beginning of the chronological account.

For Red River events, an assessment of the relative contribution of the Assiniboine is given, where sufficient information exists. This is complicated, however, by the river's geomorphological setting. At Portage la Prairie, the Assiniboine flows across an alluvial fan which elevates the channel above the surrounding terrain. Under very high water conditions, a part of the floodwaters may flow northward to Lake Manitoba, bypassing the Red River altogether, or southward into the La Salle River, joining the Red in St. Norbert 20 km. upstream of the normal junction at the Forks. There is no way of partitioning historical flows among the Lake Manitoba-La Salle-Assiniboine routes but in several floods

Year	Discharge in cubic feet per second		Comments	Primary references
	Fargo	Grand Forks		
			HISTORICAL FLOODS	
1776	--	--	Stages were about 4 feet lower than during the 1826 flood at Winnipeg. However, U.S. Geological Survey (1952, p. 290) references a Mr. Nolan (1826) who stated that this flood was larger than the 1826 flood. Some evidence for this claim is given. Elevation at Winnipeg, junction of the Assiniboine and Red Rivers, is given as 760 feet by U.S. Geological Survey (1952, p. 304). It is quite likely that the river was at least as high as in 1950 (Canada Department of Resources and Development, 1953, p. 86).	Simons and King (1922, p. 52).
1790	--	--	Stages were about 4 feet lower than during the 1826 flood at Winnipeg. Year in which general overflow occurred (U.S. Geological Survey, 1952, p. 304).	Simons and King (1922, p. 52).
1809	--	--	Stages were about 4 feet lower than during the 1826 flood at Winnipeg. Year in which general overflow occurred (U.S. Geological Survey, 1952, p. 304).	Simons and King (1922, p. 52).
1815	--	--	Water was remarkably high, overflowing its banks to a considerable distance at Fort Daer near Pembina.	Canada Department of Resources and Development (1953, p. 87).
1824	--	--	Listed as one of the worst floods known along the Red River along with 1825 and 1826.	Harrison and Bluemle (1980, p. 14).
1825	--	--	Listed as one of the worst floods known along the Red River Along with 1824 and 1826.	Harrison and Bluemle (1980, p. 14).
1826	--	--	Elevation at Winnipeg listed as 764 feet (p. 304). Maximum known flood at Winnipeg, stages about 15 feet above ordinary flood height (Simons and King, 1922, p. 52). Ice on river reached the extraordinary thickness of 5 feet 7 inches at Winnipeg. Harrison and Bluemle (1980, p.14) report the flood level to be 66 feet based on the present gage datum at Pembina.	U.S. Geological Survey (1952, p. 290-303).
1851	--	--		Harrison and Bluemle (1980, p. 14).
1852	--	--	Elevation at Winnipeg listed as 762 feet (p. 304). Flood was higher by 1 or more feet than that of 1882 at and below Grand Forks (Simons and King, 1922, p. 52).	U.S. Geological Survey (1952, p. 303-304).
1853	--	--	No farming was done in the Red River valley near Pembina due to the floods of this year and the previous two years.	Harrison and Bluemle (1980, p. 14).
1860	--	--		Upham (1895, p. 56).
1861	--	--	This flood may have exceeded the 1897 flood. Elevations are listed for Grand Forks and Winnipeg as 830 and 762 feet, respectively.	U.S. Geological Survey (1952, p. 303-304).
1871	--	--	This flood was exceeded during the 1897 flood.	U.S. Geological Survey (1952, p. 305).
1873	--	--	This flood was exceeded during the 1897 flood.	U.S. Geological Survey (1952, p. 305).

TABLE 4: Major historical floods on the Red River (modified from Miller and Frink, 1984).

prior to the beginning of gauge records and 20th Century dyking of the lower Assiniboine, significant northward flow to Lake Manitoba has been observed (for a review of these observations, see Canada Department of Agriculture, 1952).

Wherever possible, an attempt is made to infer relative magnitudes for the events on the Red to permit them to be rank ordered and compared with the modern record. The basis for these estimates is slender; in most cases, the only information available is whether the river seems to have been out of its banks (and thus exceeded channel capacity) and a sense of the extent of the flooded area. To translate this into usable estimates of magnitude, the descriptions have been compared with the areal extent of flooding during selected modern floods of differing severity. Channel capacities and discharge data for several locations on both rivers for a variety of modern floods are given in Tables 5 and 6. Figure 8 shows the flooded areas for a range of magnitudes and provides a sort of template against which the historical descriptions can be compared. In estimating these magnitudes, an attempt has been made to err on the conservative side.

Because of the highly subjective nature of the sources and their evaluation, the historical materials are given in as much detail as is practicable, to enable others to arrive at their own, and possibly differing, interpretations directly from the observers' comments. An additional reason for the inclusion of abundant original materials is that in many cases, the nature of the event can only be appreciated by the sense that is conveyed by repeated statements by differing observers or over a period of time. All references which cast light on the actual floods have been included; the others have been selected for their information value and to illustrate the sequence of events. It should be emphasized, however, that as extensive as the citations are, they represent only a small fraction of the entire database. Full references for all archival materials are included within the entry for each year. Most are from the Hudson's Bay Company Archives or Provincial Archives of Manitoba (now amalgamated into a single Archive). The references contained in the Hudson's Bay collection are prefixed by HBCA, followed by the archival reference number; those in the Provincial Archives of Manitoba are prefixed by PAM.

The interpretation of these descriptions is complicated by a number of factors beyond the imprecise nature of the descriptions themselves. Gerard and Karpuk (1979) introduced the concept of "perception stage" which they defined as

> the stage above which it is estimated the source would have provided information on the flood peak in any given year... The perception stage for archival sources such as journals, newspapers... is the minimum water level that would have called for comment. (Gerard and Karpuk, 1979, p. 1155).

This "perception stage" varies with the individual according to such factors as proximity to the river, the degree of danger or inconvenience, the length of the person's experience in the region, access to information, etc.

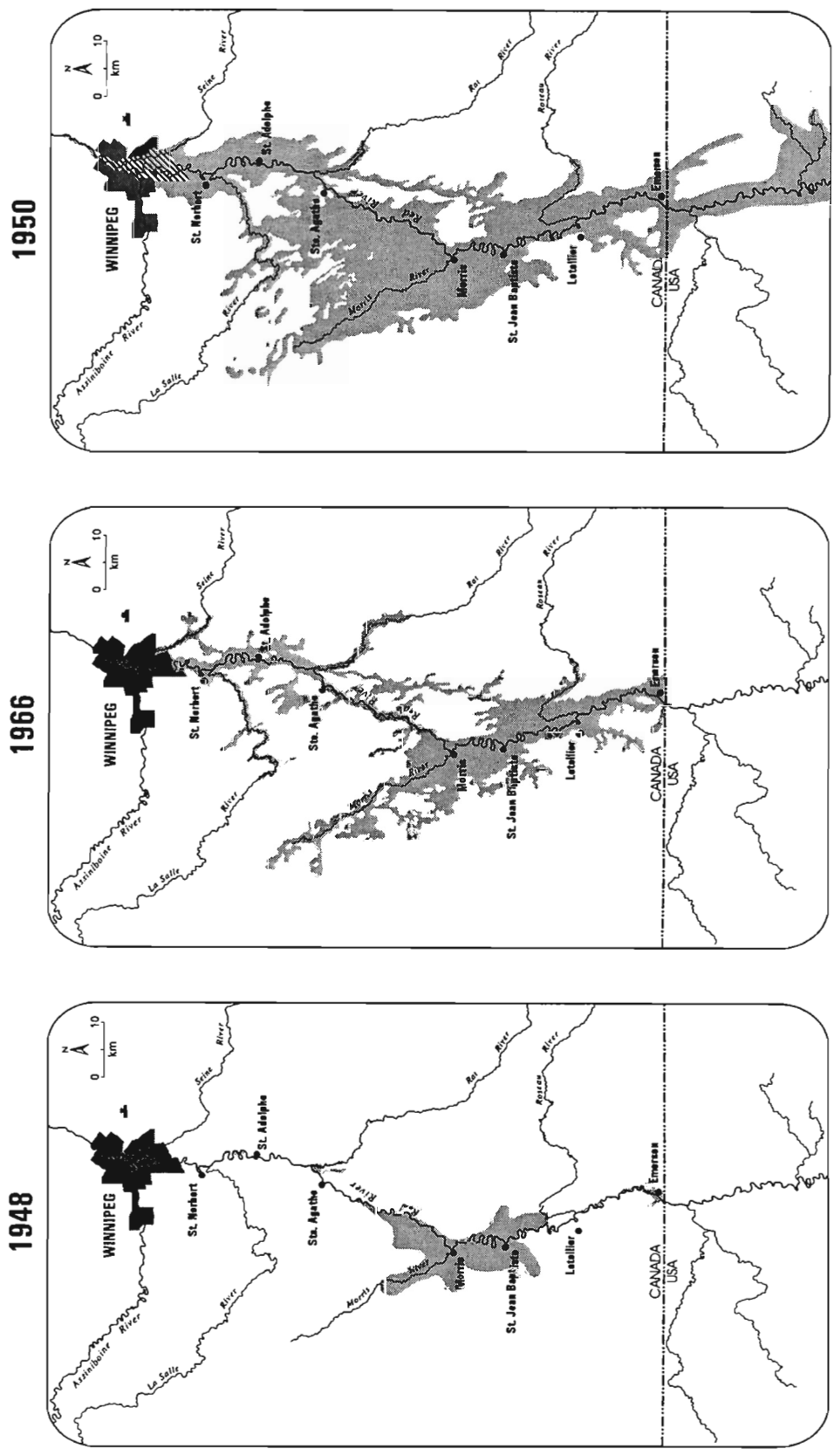

FIGURE 8: Flooded areas, 1948, 1950, 1966

TABLE 5
CHANNEL CAPACITY AND SELECTED FLOOD DISCHARGE DATA (CFS), RED RIVER

	Emerson	Ste. Agathe	Below Forks
Channel capacity	38,000[1]	69,000[1]	69,000[1]
1826	—	—	225,000
1852	—	—	165,000
1861	—	—	125,000
1916	46,000	—	86,000
1948	52,000	—	75,000
1950	94,000	—	108,000
1966	66,000	66,000	88,000
1974	43,000	88,000	96,000[2]
1979	92,000	72,000	107,000[2]
1996	72,000	78,000	108,000[2]
1997	139,000	130,000	162,000[2]

[1] Canada Department of Resources and Development, 1953.
[2] Natural discharge (Manitoba Water Resources)

TABLE 7
CHANNEL CAPACITY AND SELECTED FLOOD DISCHARGE DATA (CFS), ASSINIBOINE RIVER

	Portage la Prairie	Brandon	Russell
Channel capacity	15,000[1]	8,200[2]	1,500[1]
1882	—	40-48,000[4]	—
1904	—	28-32,000[4]	—
1923	22,100	23,000	14,500
1974	32,000[3]	10,900	2,500
1976	53,000[3]	22,100	2,900

[1] Undyked capacity (Mudry et al., 1983) [2] Manitoba Water Resources [3] Discharge at Holland [4] Canada Department of Agriculture, 1952

Note on Units: Because the Imperial unit for discharge (cubic feet per second) strongly engrained in the literature on Red River floods (including the reporting of discharge during the 1997 flood) and in the minds of the local hydrologic community, this unit will be used in this report.

On the Red River, the definition of "perception stage" is made more problematic by a number of factors relating to the nature of major floods, the pattern of settlement in the region, and the information which would have been available to local observers (mostly residents of the Red River Settlement):

- During much of the period being considered here, the only documents in the Red River valley were from the vicinity of the Forks and to a lesser extent, Pembina. On the Assiniboine, the furthest downstream site which left written records was Brandon House, and above that, Fort Pelly. Communication among these was infrequent at best and thus the advance warning of flooding and information about such factors as the winter snowpack, areal extent of spring precipitation, etc. available to residents of the Forks region was negligible.

- In the largest events, floods form in the United States portion of the basin and the crest travels northward. Because of the very gentle downstream gradient, the time from the beginning of snowmelt to the peak stage in the vicinity of the "Forks" is long, typically several weeks. The melt season is usually well-advanced or even completed in the vicinity of modern-day Winnipeg before the magnitude of the impending flood could be perceived. Thus local descriptions that the prairies near the Red River Settlement were almost snow-free, for example, are not inconsistent with a later description of a major flood.

- The perspective of the great majority of observations was from the Red River Settlement whereas the causes of the flood may have been principally due to conditions in the upper basin of present-day North Dakota and Minnesota, far from the Red River Settlement. Consequently, conditions as they were described around the Settlement may be a poor reflection of the flood potential.

- The pattern of occupation in the Red River Settlement, and particularly the locations of those who left written documents, would have placed particular restrictions on the "perception stage" of observers. Only floods of 1950 magnitude or larger would have extended flooding as far as the Settlement and have had any direct consequences for its inhabitants. In 1950, the flooded area of Winnipeg (Figure 9) widened southward from a narrow apex in the vicinity of the Forks. Whereas the area to the south of the Forks was extensively flooded, only a narrow corridor for a few miles north of the Forks was threatened. In the Red River Settlement, virtually all of the observers who left written documents lived on the west bank of the river north of the Forks and after the opening of Lower Fort Garry in 1831, many observers lived outside of the area directly threatened by even the largest floods. Consequently, it is conceivable that floods of 1948-1966 magnitude could have occurred with little commentary from those in the region of the Forks, other than perhaps a comment that the river is high. The occupants of the river banks in the Upper Settlement parishes of St. Boniface, St. Vital, St. Norbert, Ste. Agathe and further south would certainly have been affected by floods of 1950 or

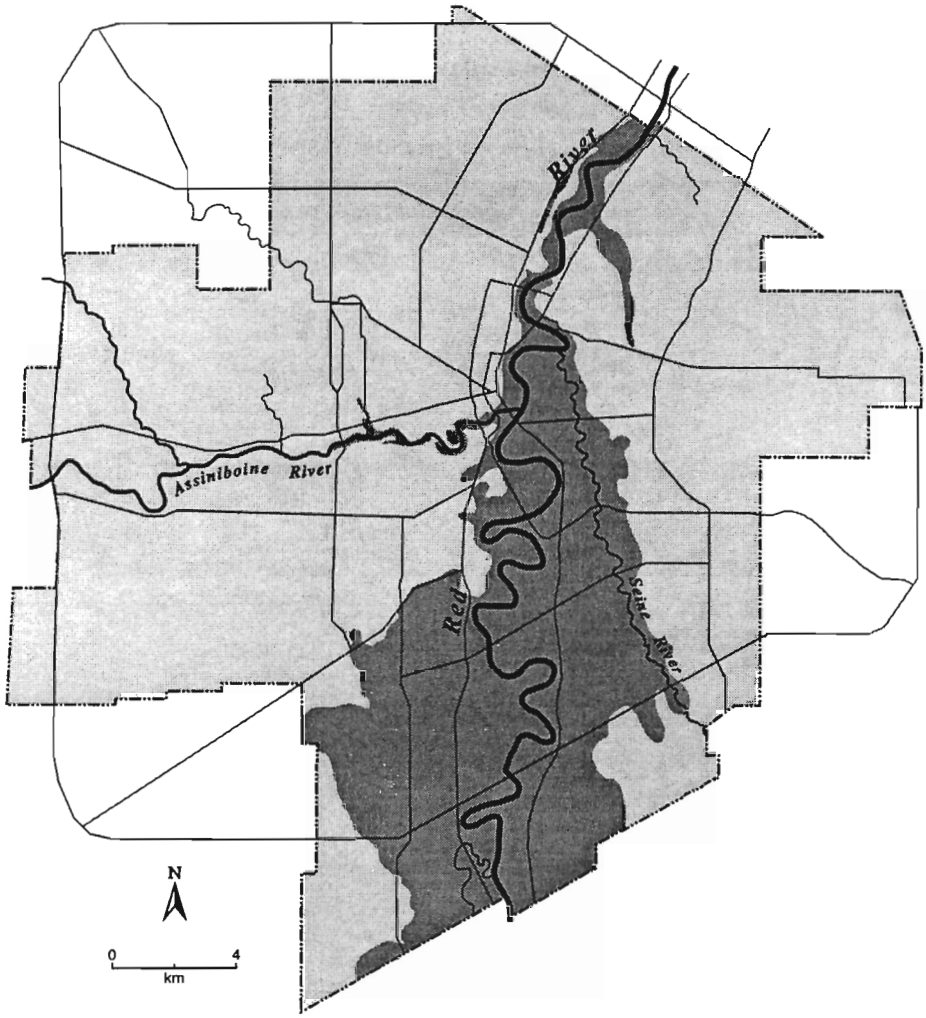

FIGURE 9: Flooded area, Winnipeg, 1950 (including dyke-defended areas of St. Boniface and St. Vital)

possibly even 1966 magnitude but they left no written documents. On the Assiniboine, the river downstream of present-day Headingley becomes progressively entrenched and flooding upstream of White Horse Plain might have gone unrecorded by observers in the Settlement.

- The residents of the Red River Settlement had only their own situation to worry about, in contrast to 20th Century floods after extensive settlement of the Valley when factors such as evacuations, disruption of communications, concerns about loss of agricultural production, widespread property damage, etc. became more prominent. In other words, except in the very largest events, there was little reason for the inhabitants of the Settlement to be concerned about overbank conditions to the south, almost regardless of magnitude.

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1790

Although a flood in 1790 is listed in most compilations, the only source reference to the event is by Alexander Ross:

> The Indians likewise mention a flood about the year 1790. (Ross, A., 1856 (Reprinted 1957). The Red River Settlement: Its Rise, Progress, and Present State. Ross and Haines, Minneapolis, Minnesota, p. 107)

No archival records exist for this year to confirm or deny the event.

1797

ASSINIBOINE

Spring

The upper Assiniboine was reported as very high in May, 1797, in the Brandon House Journal.

April 27: ...water rising fast in the [Assiniboine] river and the ice breaking away in small pieces. (Brandon House Journal, HBCA B.22/a/4 1796/97)

April 30: ...the [Assiniboine] river open water very high. (ibid)

May 7: ...the water is higher in the [Assiniboine] river than ever any man of the oldest time has seen it...[it has risen?] 10 feet perpendicular where there was not one drop last year. (ibid)

May 18: Cannot get the Boats repaired and all the houses filling with water. (ibid)

ANTECEDENT CONDITIONS:

The Brandon House and Fort Pelly Journals contain references that the water level in the Assiniboine was very low in the fall of 1796:

Sept. 8: leading almost all day, hard work, water low making the Journey very disagreeable. (ibid)

Oct. 20: the Batteaux was Stopt by Ice and the Shallowness of the Water in the [Assiniboine] river.... (Fort Pelly Journal B.159/a/3 1796-97)

Winter appears to have set in relatively early:

Oct. 21: It snowed and froze so much Last night that it set the [Assiniboine] River fast. (ibid)

Nov. 12: ...am sorry you had such a troublesome Journey in the fall, owing to the early setting in of the [Assiniboine] River She filled with Ice here [Brandon House] the 24th of Oct. but was not totally set fast before the 12th of Nov. since which time we have had much snow and very severe weather. (Letter, James Sutherland [Brandon House] to John Sutherland [Fort Pelly], dated Jan. 3, 1797, in Fort Pelly Journal, op. cit.)

Daily records in both journals report numerous heavy snowfalls throughout the winter, with periodic thawing beginning in mid-March. Heavy snow fell in April after the water began rising on April 13 and during the flood period:

April 15: As bad a day as ever was seen in this or any other Country...it fell more than a foot of snow. (Brandon House Journal, op. cit.)

April 16: heavy snow till noon, snow 18 inches deep in the yard. (ibid)

April 18: More snow in the afternoon, cold disagreeable weather, the earth loaded with snow, no sign of the Rivers braking. (ibid)

April 19: Snowy Day...I left this place this day 12 months [ago] to go down to Brandon House, the [Assiniboine] River being open six Days befor, but no sign of her opening this year yet. (ibid)

April 21: Rainy weather all day. (ibid)

April 22: heavy rain all day. (ibid)

April 23: Very cold weather with snow last night, scarcely thaw'd on the hight of the day. (ibid)

Cold weather continued through the first three weeks of May, becoming generally "fine" thereafter.

SUGGESTED MAGNITUDE:

Little can be said about flood magnitude other than it was overbank at Brandon.

1798

RED

Spring

Independent comments on this flood are given in journals by Thomas Miller at Red River and Charles Chaboillez at Pembina:

> April 4: the [Red] River turning very Weak and the water Rising very Fast. (Journal of Transactions by Thos. Miller at Red River B.235/a/1 1797/1798)
>
> April 8: Rains very hard all day ice driving in the [Red] River and the water Rising very high. (ibid)
>
> April 9: The Ice in the River [at Pembina} all brook- the Water being High. (Journal of Charles Chaboillez in Payette, B.C. (ed.), 1964. The Northwest. Payette Radio Ltd., Montreal, p. 202)
>
> April 11: ...ice driving in the River. (Miller, op. cit.)
>
> April 12: The water [at Pembina] now very high in the night we were obliged to carry all the Goods etc. out of the Fort...the Water came up to the Floor in the night. (Chaboillez, op. cit.).
>
> April 12: the water [at Red River} rising to a prodigious height. (Miller, op. cit.)
>
> April 13: the water [at Pembina] still rises. (Chaboillez, op. cit., p. 202)
>
> April 14: the water [at Pembina] still rises. (ibid, p. 202)
>
> April 15: The Channel [at Pembina] clear. (ibid, p. 203)
>
> April 17: The Water [at Pembina] rose a great Deal since two days-say over the square of the House and still continues a rising... (ibid, p. 203)

There are no further references to the height of the water after April 17 so it is assumed that the level began to lower shortly thereafter and did not produce an extensive overflow.

ANTECEDENT CONDITIONS:

Journals from Fort Pelly, Brandon House and Pembina report numerous and apparently substantial snowfalls throughout November. The daily entries at these posts portray the ensuing winter as unusually gentle, with few severe periods separated by many days described variously as "gentle, "thawy", "mild", "fine", etc.

> Jan. 29: it has been a very mild winter here which [is] the cause I imagine the Buffalo Cows has been so Long in coming. (Fort Pelly Journal B.159a/4 1797-1798)
>
> Feb. 28: weather as befor,-it has been the mildest weather, the 2 last Months, I ever seed since I have been in this country. (ibid)

Mild temperatures continued into March, accompanied by several closely-spaced and substantial snowfalls, eg.

> Mar. 9: Wind East with the greatest fall of snow I saw this year. (Brandon House Journal, HBCA, B.22/a/5 1797/ 98)

These storms left a covering of deep, wet snow:

> Mar. 14: Our journey [between the Forks and Pembina] for the last eight days has been wretched travelling; the Snow was full three feet deep; the ice of the River had much water on it, from the mild weather with small showers of rain, or wet snow. (Alexander Henry in Coues, I. (ed.), 1965. The Manuscript Journals of Alexander Henry and of David Thompson. Ross and Haines Inc., Minneapolis, Minnesota, p. 185)

Thawing began in earnest in the last week of March, with rain commonly reported:

> Mar. 27: The snow was thawing and wet; very bad walking. (ibid, p.189)
>
> Mar. 29: Rained all night & still a Raining [at Pembina]. (Chaboillez, op. cit., p. 199)
>
> Mar. 29: Rain continued until noon; The Snow was now so mixed with water that we could not proceed. In the evening Rain came on and continued. (Henry, op. cit., p. 189)
>
> Mar. 30: Showers of Hail and Sleet. With the Guide went to examine the country before us: which appeared like a Lake, with water. (Brandon House, op. cit.)
>
> Mar. 31: Here [at Red Lake River] a few days has thawed three and a half feet of heavy snow. (David Thompson, in Henry, op. cit., p. 190)

This early spring led to the Red River at the Forks opening on April 7, a very early date in a 19th Century context. (Miller, op. cit.).

STATE OF THE ASSINIBOINE:

Journals from Fort Pelly throughout the flood period do not mention the state of the Assiniboine and it is assumed that it was not unusual. This inference is supported by the observation at Fort Pelly on May 6 (three weeks after the flood period) that the "the [Assiniboine] River [is] very Shoald." (Fort Pelly Journal B.159/a/4 1797-1798).

SUGGESTED MAGNITUDE:

The river seems to have been overbank at Pembina but does not appear to have inundated a large area and there is no indication that it was overbank at Red River in the vicinity of the Forks. It may have been comparable to 1948.

1801

ASSINIBOINE

Spring

This high water event is reported from the upper Assiniboine.

April 16: the [Assiniboine] river is quite free from ice here & the water seems to be high. (Archibald McLeod in Gates, C.M. (ed.), 1965. Five Fur Traders in the Northwest. Minnesota Historical Society, St. Paul, Minnesota, p. 173)

May 10: Still raining, & cold the water [in the upper Assiniboine] is remarkably high, & all the low ground hereabout is entirely deluged. (ibid, p. 179)

May 11: Still very bad weather, the water rising very fast. (ibid, p. 179)

May 12: A Cold cloudy day, Snowed & rained a little all day...the water [in the upper Assiniboine] is extremely high, and far from decreasing it still increases. (ibid, p. 179)

May 14: ...Jacco...reports the water is so excessively high that all the plains & in particular those bordering on Lakes and rivers are overflowed which is far from being favourable for the beaver hunt, the water has risen 3 feet perpendicular since yesterday...the Rivers are so high they could not cross them. (ibid, p. 180)

May 17: We sett off as soon as it was light to follow the people who could not cross at the usual crossing place of the S. River the water being so extremely high that all the points were entirely under water, & never did I see such heavy roads. (ibid, p. 180-181)

May 19: ...the men tell me the Houses at Swan River had two feet water on their floors, when the water rose, & that they had not a Dry bit of ground, within three or four leagues of the Fort all around the overflowing of the River having laid all underwater [on upper Assiniboine]. (ibid, p.182).

May 20: ...the [Assiniboine] River still overflows the banks, & there is water on the House floor as yet. (ibid, p. 182)

May 22: ...sent people to fish. tho' the water is so high that they have very little success. (ibid, p.182)

Although these references are all from the upper Assiniboine, there is some evidence that stages on the Red were also high (although apparently not overbank). At Pembina, Alexander Henry reported:

April 18: drowned buffalo still drifting down the river. (Alexander Henry in Coues, I. (ed.), 1965. The Manuscript Journals of Alexander Henry and of David Thompson. Ross and Haines Inc., Minneapolis, Minnesota, p. 175)

The observation of "floating buffalo" was not uncommon and does not imply flooding, but it does suggest that water levels were sufficiently high to present problems. Entries by Henry in 1802 suggest that stages had been notably high the previous year:

May 9, 1802: It required 90 fathoms of net to cross the [Red] river as the water is high, and the strong current forms a great bend. (ibid, p. 197)

May 11, 1802: Water falling it had risen almost as high as last year. (ibid, p. 197)

ANTECEDENT CONDITIONS:

The fall of 1800 began early with reports of severe cold and snow in October at Pembina and Brandon House:

October 14: sharp weather [Assiniboine] river full of driving ice. (Brandon House Journal, HBCA B.22/a/8 1800-01)

October 16: It began to snow and blow hard from the N...The snowstorm increasing...it snowed all night [at Pembina}. (Henry, op. cit., p. 120)

Subsequent milder weather seems to have delayed permanent complete freezeup of both rivers until mid-November. Mild conditions in late November continued throughout most of December and January.

January 22: ...the Buffaloe are going further off very fast owing to the extraordinary mildness of the weather, people go days journeys without mittens so very fine is the weather. I took a ride on horseback today of upwards of an hour without gloves & felt not the least cold. (McLeod, op. cit., p. 154)

Heavy snow fell on the upper Assiniboine region in late January-early February but melted with subsequent warm weather.

March 5: The snow being entirely melted [at Pembina], and the ground thawing about noon, renders it very muddy, at times over the shoes. (Henry, op. cit., p.171)

March 7: As fine a day as the two preceding. all the Ice & Snow is entirely melted in the Fort [upper Assiniboine]. (McLeod, op. cit., p. 162)

March 14: As fine a day as yesterday...the snow is absolutely quite gone the other side of Mr. Perignes' Fort [on upper Assiniboine]. (ibid, p. 164)

March 14: The ice [on the Red at Pembina] is rising in a body, in consequence of the melting snow. Being apprehensive the water would come into the fort and overflow the property. (Henry, op. cit., p. 173)

March 19: The river continues to rise and is now only a few feet from the gate. Got out my canoes...and placed them in the fort ready to load, to save ourselves in the plain in case the water rises suddenly. (ibid, p. 173)

March 21: My anxiety about the water increasing, I set the men to work. (ibid, p. 173)

Rain and snow fell on several days in late March and a change to colder weather

caused it to begin to accumulate again.

> March 30: Snowed constantly from ten oClock A.M. untill the evening when it ceased & the weather became much colder [on upper Assiniboine]. (McLeod, op. cit., p. 168)
>
> March 30: Rain broke up the ice...The water is falling, leaving us an ugly, dirty bank, covered with nearly a foot of slime and mud; had it risen two feet more, we should have had it in our houses. A heavy fall of snow. (Henry, op. cit., p. 174)
>
> April 5: The plains [around Pembina] have been clear of snow and dry, we had two feet of snow and the river nearly froze over again. We brought our baggage into the fort. (ibid, p. 174)

The elevation of the upper Assiniboine to flood stage seems to have been the result of frequent and significant precipitation in the second half of April and the first weeks of May. McLeod reported rain or snow on 7 days from April 15 to April 30 and on 14 days from May 1 to May 18.

SUGGESTED MAGNITUDE:

No estimate.

1806

RED

Summer

This flood on the Red occurred during the summer and is known only from Alexander Henry's journal at Pembina and vicinity.

> June 6: Water [on the Red] extraordinarily high and continued storms which breed an incredible number of mosquitoes. (Alexander Henry in Coues, I. (ed.), 1965. The Manuscript Journals of Alexander Henry and of David Thompson. Ross and Haines Inc., Minneapolis, p. 281)

> July 7: The travelling was redious from the heavy rains which made ugly and laborious walking for our horses...In many places we found several feet of water, every little hollow formed a pond, and every rivulet appeared like a river. Our horses often sunk up to their knees in mud, and at times had water up to their bellies...The water [in the Red] was very high...They attempted to go there [to the east side of the Red] but found the country almost entirely overflowed. (ibid, p.285-286)

> Aug. 13: This summer's extraordinary rain, having overflowed the low country, has caused the buffalo to resort to the high lands southward. (ibid, p. 420)

> Aug. 14: We found a great quantity of water, and for a long distance our horses had it up to their bellies...This road used to be firm and good but the continued rain of the summer has altered the face of almost everything, and there is now mud and water knee deep [between Escarpment and Pembina Post]. (ibid, p. 421)

Peter Fidler's journal entry for May 16, 1820, confirms the exceptionally high water in the Assiniboine basin in the summer of 1806:

> found the East end of our House [at Fort Dauphin] 4 feet 9 1/2 Inches higher than the water in the Lake-the Summer 1806 it was all covered with water. (HBCA B.51/a/2 1819/1820)

ANTECEDENT CONDITIONS:

Henry's journal contains only scattered references to weather during the winter of 1805-06. It seems to have been cold and snowy, particularly in the late winter and early spring.

> Mar. 17: All my people laid up snowblind with sore eyes occasioned by the continual storms and drift. (Henry, op. cit., p. 274)

> April 13: Dreadful snowstorms. (ibid, p. 275)

> April 23: Ice broke up in Red River [at Pembina]. (ibid, p. 275)

> May 1: Great banks of snow still lying on the edge of the woods. This certainly has been the most extraordinarily cold and stormy weather I have ever experienced on Red River. (ibid, p. 275)

> May 4: A deluge of rain; our stores flooded and the property damaged. (ibid, p. 275)

Henry's descriptions of the flood in the summer indicate that it was caused by the "continued storms". "heavy rains", "extraordinary rain", etc. from June through August.

STATE OF ASSINIBOINE:

There is no direct reference to the Assiniboine in Henry's reports but Peter Fidler's description of the high level of Lake Dauphin (4 feet 9 1/2 inches higher than in 1820) indicates that the Assiniboine basin probably received similarly heavy rainfall, particularly since Fidler remembered and chose to mention the summer of 1806 fourteen years later.

SUGGESTED MAGNITUDE:

Henry's description indicates that the river was over its banks and suggests that the inundated area extended for some distance beyond the river. There are no modern counterparts for this magnitude of summer flow but a level similar to or smaller than the spring flood of 1948 seems appropriate.

1809

A flood in this year has appeared on most previous compilations, based on a single comment by Alexander Ross:

> ...the natives now on the ground affirm that in 1809 the water rose unusually high. (Ross, A., 1856 (Reprinted 1957). The Red River Settlement: Its Rise, Progress, and Present State. Ross and Haines, Inc., Minneapolis, Minnesota, 419p, p. 107)

There is no mention of the event by observers at Pembina during April and May of 1809 whose only diary entries relating to the river were:

> April 14: The ice [in the Red] took a start. (Journal of Occurrences at Pabina River, 1808-09 B. HBCA 160/a/1 1808/1809)
>
> April 15: Raining. (ibid)
>
> April 16: the [Red] River entirely clear of ice. (ibid)
>
> May 23: Wind and rain which obliged us to stop the whole Day. (ibid)

On April 10, the Brandon House Journal reported on conditions in the Assiniboine basin:

> April 10: not...able to get the least thing hauled home for want of snow. (Brandon House Journal, HBCA B.22/a/16 1808-1809)

Thus it concluded that a flood in this year was very unlikely and that the event remembered by the "natives on the ground" probably refers to the 1811 event discussed below.

1810

ASSINIBOINE

Spring

The only evidence for this event comes from a few entries in the Brandon House Journal.

April 19: its not possible to burn Charcoal as the Bluff is overflowed with water. (Brandon House Journal, HBCA B.22/a/17 1809-1810)

April 23: the Water [in the Assiniboine] is extremely high. (ibid)

April 26: Sent John Easter and Thomas Favil to the Sourie to dart Sturgeon they returned in the Evening and say's the Water is too high. (ibid)

June 1: they returned and complains of the Water [in the Souris] being yet too high for darting [sturgeon]. (ibid)

ANTECEDENT CONDITIONS:

No information.

SUGGESTED MAGNITUDE:

No estimate.

1811

RED

Spring

The only references to this event are in two letters written from York Factory in October of 1811 which, although having different authors, would probably have relied on common sources of information.

> An extraordinary inundation occurred this spring on the South or Pembina branch of the Red River, which overflowed its banks to the extent of 4 miles on each side of the river into the Country while the Northern branch was not more swollen than usual. This flood was occasioned by the melting of snows which fell last winter towards the source of that [river] uncommonly great. Such a circumstance has not been before in the memory of the oldest Indian, & perhaps may happen again. (Letter, Miles MacDonell [York Factory] to Lord Selkirk, Oct. 1, 1811, [Note F] Sessional Papers [No. 12], British House of Commons, p.CXCV).

> You will learn with great mortification that the S. Branch or proper Red River was so overflowed that Mr. Henry's House in the Pabina was under water for 28 days the bed of the River generally 5 feet deep was increased to 55 & the Country on both sides deluged forming a Lake thro' its whole Course of about 8 miles wide instead of being only 100 & oftener only 50 yards in breadth. (Letter, William Auld to A. Wedderburner, dated York Fort, Oct. 5, 1811, Selkirk Papers, vol. 1, p.86-87, PAM M171).

Given the apparently extreme (and thus memorable) nature of this flood, the vagueness of Ross' sources on the 1809 event, and the lack of commentary by observers at Pembina in that year, it seems most likely that this is the event being reported on as 1809 in Ross' book and followed by other compilations.

ANTECEDENT CONDITIONS:

MacDonell's letter attributes the flood to very heavy winter snowfall which fell in the southern part of the basin (at least). Little other useful information is available to assess the flood-forming conditions , other than two reports of significant rain at Brandon House in late April and mid-May:

> April 29: a bad day Continually raining and blowing. (Brandon House Journal HBCA B.22/a/1 1810/1811)

> May 16: a bad day Continually raining. (ibid)

STATE OF ASSINIBOINE:

Both sources clearly state that the flood was on the Red River only and Auld's letter indicates specifically that the Assiniboine (North Branch) was "...not more swollen than usual.", implying that it was probably less than bankfull.

SUGGESTED MAGNITUDE:

The descriptions indicate an exceptionally large flood. The extent of the flooded area was described as 8 miles in breadth and the total rise as about 50 feet. By comparison, the 1950 flooded width was about 8 miles at Emerson/Pembina and somewhat less at many places to the north and south (except near Morris); the total rise in 1979 was 39 feet and in 1997 was 40 feet. Even if the total rise was considerably exaggerated, this event must have exceeded 1950/79 and may have approached 1861.

1815

RED

Spring

The evidence for a significant flood in this year is from the following entries in Peter Fidler's Journal.

> May 19: Water remarkably high in Red River overflowing its banks to a considerable distance, the water at Fort Daer rose to within 4 inches of the Upper part of the Door within the fort. The water rather lower than usual on the North Branch and damed up above the forks above 10 miles, tho' the river has a considerable descent, very deep snow in Red River this winter & most all the Horses died in consequence. (Peter Fidler's Journal, HBCA B.235/a/3 1814/1815)
>
> May 26: The water is very high in the Red River and has not yet begun to abate it is about 10 feet below the bank at the settlement on the N. side, but into the woods on the other side. Water so high that very few fish are caught. (ibid)
>
> June 4: the water falling fast daily-very few leaves have yet made their appearance. Indians arrived from Lake Winnipeg say it is fast yet except a little water along the shore. (ibid)
>
> June 10: water falling about five inches perpendicular daily. (ibid)

ANTECEDENT CONDITIONS:

There is some indication that the previous (1914) fall was relatively wet:

> Sept. 27: Rain. (ibid)
>
> Sept. 28: could not work from rain these two days. (ibid)
>
> Oct. 6: water rising very fast these 5 days. (ibid)

Fidler's account of May 19 (above) indicates that there had been "very deep snow in Red River this winter & most all the Horses died in consequence."

Breakup of the Red was relatively late (although not especially unusual in a 19th Century context):

> April 21: part of the [Red] river gave way at the N.W. Fort. (Journal No. 2 of Archibald McDonald. Kept at Red River Settlement, Selkirk papers, vol. 68, p. 18320)
>
> April 22: The ice moved [in the Red] & stopped again [at Red River Settlement]. (Miles McDonell's Journal No. 4, Selkirk Papers, vol. 63, p.16993-94)
>
> April 23: Some large openings are made in the river but the main body of ice remains yet fast. (ibid)

April 24: The Ice gave way, the snow is going fast. (McDonald, op. cit., p. 18320)

The flood peak at Pembina was very late (May 26-June 6) in the context of modern floods.

Reports from Brandon House and Peter Fidler's journal suggest that considerable rain fell during the course of the flood:

May 22: rain all night. (Brandon House Journal, HBCA B.22/a/19 1815/1816)

May 25: Thunder Lightening & rain. (ibid)

May 30: Rain fell these two days. (ibid)

May 31: Rain nearly all day. (Peter Fidler's Journal, op. cit.)

June 3: Showers, Thund. & Lightning. (Brandon House Journal, op. cit.)

STATE OF ASSINIBOINE:

Fidler's May 19 entry above indicates that the Assiniboine (North Branch) was "rather lower than usual". However, a rather different impression is given by the following entry:

November 11, 1815: The Grande Marie [at Portage la Prairie] is a beautiful part of the country. The Marie or rather Lake encircles a considerable point of land covered with Oak, Elm and Maple, when the water rises this Lake overflows and forms swamps in the low meadows which appears to have been the case last spring. (Colin Robertson's Diary, at Fort Douglas, Vol. III (1815), HBCA E/10/1)

Because this latter observation is more first-hand, it is concluded that the Assiniboine was more probably high, at least bankfull at Portage la Prairie (c. 15,000 cfs).

SUGGESTED MAGNITUDE:

Difficult to assess. The water seems to have been out-of-bank on one side of the river at least, but there is no indication that extensive areas were flooded. Discharge greater than 1948 but less than 1966 seems most likely.

1824

RED

Summer?

A flood in 1824 is listed by Miller and Frink (1984), citing Harrison and Bluemle (1980) who stated "The worst floods known along the Red River occurred in 1824, 1825, and 1826." (p.14). Harrison and Bluemle gave no source for their information but it may have been the statement by Bond written three decades after the event:

> The heaviest floods known in the country occurred in 1824, '25, and '26. (Bond, J. Wesley, 1857. Minnesota and Its Resources, to which are appended Camp-Fire Sketches or Notes of a trip from St. Paul to Pembina and Selkirk Settlement on the Red River of the North. Kenn & Less, Chicago, Illinois, p. 23)

This is the only direct reference to the event known to the writer. Unfortunately there is no mention of a spring flood in the meagre first hand accounts which have survived from 1824.

Freezeup in the previous fall was not abnormal:

> November 6, 1823: The [Red] river is now completely set fast, and will be so till April. (Rev. D. Jones Journal, PAM, MG7 B2 CMS A77.)

The spring of 1824 seems to have been exceptionally late:

> May 16: The Spring is very backward, and snow on the ground yet in some places since November last. (ibid)

> June 7: It rained heavily all day...The Lake was yesterday clear of ice. (Red River Journal, HBCA B.235/a/6 1824/25)

The summer appears to have been excessively wet. Rain was reported in the Red River and Fort Pelly Journals on a great many days from June to August and must have been heavy and widespread since it caused both the Red and particularly the Assiniboine River to rise.

> June 19: The Weather continues boisterous. The nets could not be set in either of the Rivers in consequence of the hight of the water and strength of the current. (ibid)

> July 2: Heavy rain and Thunder. The waters of the [Assiniboine] river [rose] two feet since last night. (Fort Pelly [S.R.House] Journal, HBCA B.159/a/8 1824-25)

> July 10: ...could not work the gardens on account of the heavy rains, which makes the waters in the [Assiniboine] river rise fast. (ibid)

August 4: At noon a heavy rain. The meadows being so full of water, it is a difficult job to get the hay dried. (ibid)

August 15: The weather overcast raining for the greatest part of the day...Continued rains for some time past, made the waters of the [Assiniboine] River rise five feet above its usual height. (ibid)

August 16: The weather very cloudy, and the waters of the [Assiniboine] river rising more and more. (ibid)

August 18: The weather overcast, some rain at intervals and the waters of the [Assiniboine] river continue rising so much, that they nearly reach the top of the bank...(ibid)

August 21: The rains still continued pouring and the [Assiniboine] river rising more and more. (ibid)

September 2: The weather continues wet, which has caused the [Red] River to raise considerably. (Red River journal, op. cit.)

STATE OF THE ASSINIBOINE:

The Assiniboine basin appears to have also experienced very heavy summer rainfall and at least approached bankfull in it upper reaches in August.

ASSESSMENT:

The streamflow was clearly high during this extremely wet summer but there is no indication that either the Red (in the vicinity of the Forks) or Assiniboine were overbank to any extent. In the absence of further information, a significant flood in 1824 cannot be confirmed.

1825

RED, ASSINIBOINE

Spring, Summer

Perhaps because of its proximity to the 1826 flood, this apparently major event has received little attention in other compilations. For this reason, and because it seems to have risen to a second peak and remained high all summer, it will be described here in some detail.

April 12: About noon the Red River broke up and the ice continued drifting without interruption during the remainder of the day. (Red River Journal, HBCA B.235/a/6 1824/1825)

April 13: There is now a scarcity of provisions in many parts now owing to the failure of the Sturgeon fishery; this is owing to the continuance of high water. (David Jones Journal, 1824-1825, PAM CMS 18 A92)

April 13: The Red River continued full of drifting ice and the water in it rises rapidly. (Red River Journal, op. cit.)

April 15: The ice in the Assiniboine River broke up and continued drifting down with great velocity during the day-The water in both Rivers rises very fast. (ibid)

April 16: The Assiniboine River continued full of drifting ice, and the water in both Rivers rises very fast, so much so, as to overflow their banks in several places. (ibid)

April 26: The [Red] river is rising to a formidable height this year; the houses at Pembina are all overflowed; and several between us and lake Winnipeg will be under water to morrow. (Jones, op. cit.)

April 26: Rained heavily all day...The water is so high in both Rivers, as to cause them to overflow their banks, in consequence of which, many of the settlers have been obliged to abandon their houses. In several of the fields, which were sown with wheat some days ago, the owners have set their nets, and procured therefrom, abundance of fish; so extraordinarily high is the water this year. (Red River Journal, op. cit.)

April 30: The water in both Rivers continues to rise very fast. (ibid)

May 2: The Rivers still continue rising and the Settlers, whose fields are greatly inundated, are consequently much retarded in their labours. (ibid)

May 3: [Rafting of logs and firewood] proved unsuccessful...owing to the extraordinary inundation of the river [which carried the wood] back from the banks of the River, where it lay, into the woods where it is now floating about. (ibid)

May 14: The inundation begins to subside. (ibid)

May 17: The Rivers are falling very fast. (ibid)

As the rivers began to recede from the snowmelt peak, heavy, frequent, and apparently

widespread rainfall produced a second rise.

May 22: Made several ineffectual attempts to cross the Assiniboine River [near junction with Qu'Appelle] owing to its high state & the Depth of Mud at its edges...(George Simpson in Merk, F. (ed.), 1968. Fur Trade and Empire: George Simpson's Journal with Related Documents. The Belknap Press of Harvard University Press, Cambridge, Massachusetts, p. 161)

May 26: Incessant rain throughout the Day... (Simpson near Pine Fort, ibid, p. 162)

May 27: Passed a dismal Night, soaked with continual Rain (Simpson between Pine Fort and Portage la Prairie, ibid, p. 162)

May 28: I should push on ahead on foot in hopes of reaching the White Horse plain but we had not gone far when we found the low Grounds near Long Lake inundated we had therefore to pass through a Swamp of 9 Miles in length frequently up to the Waist in Mud and Water.... (Simpson east of Portage la Prairie, ibid, p. 162)

May 29: The [Assiniboine] River rising rapidly owing to the Recent rains. (Fort Pelly Journal, op. cit.)

June 6: Cloudy with intermitting rains, the State of the [Assiniboine] River is Such as to become alarming to a degree having already overflowed its banks, and entirely deluged our Gardens. (ibid)

June 14: [we learned] that our horses were Safe and though up to their Bellies in water were Still in good order, it must be observed that there is not a foot of dry ground within 2 miles of them. (ibid)

June 17: The water has fallen considerably. (ibid)

Flooding or high water continued on both the Red and Assiniboine throughout the entire summer.

June 6: The water has risen considerably this year as has happened sometimes before. It has almost covered the prairies at Pembina and above and flooded all the houses of the place, not excepting the chapel, where it has entered to a height of several feet. (Bishop Provencher [St. Boniface] to Bishop Plessis [Quebec City] in Nute, G.L., 1942. Documents Relating to the Northwest Missions. Minnesota Historical Society, St. Paul, Minnesota, p. 431)

June 21: Very few fish have been caught this season in the River, owing to the unusual height of the waters; nor can any improvement be expected in the way of fishing, until the floods abate. (Red River Journal, op. cit.)

June 29: The floods increase at the rate of one foot perpendicular, every twenty-four hours; whereby the fishery in the Rivers is entirely interupted. (Ibid)

July 11: The floods in the River continue high... (ibid)

July 15: The Rivers continue much swelled, but invariably rise or fall as the weather is wet or dry. (ibid)

July 18: The floods in the Rivers begin to subside... (ibid)

July 30: ...we are not as yet able to get the rafts unloaded the beach being still covered with twelve feet water. (ibid)

July 30: the [Assiniboine] River considerably swollen. (Fort Pelly Journal, op. cit.)

August 1: ...the [Red] river rising rapidly. (Red River Journal, op. cit.)

August 3: the [Assiniboine] River falling off. (Fort Pelly Journal, op. cit.)

August 20: much damage is done to the wheat crops in general by the smut and mildew, which are supposed to be the effects of the unusual high waters this season. (Red River Journal, op. cit.)

September 23: Owing to the late heavy rains, both Rivers have risen considerably. (ibid)

ANTECEDENT CONDITIONS:

The summer and fall of 1824 were extremely wet. Rain described as "excessive" and "heavy" was reported from Red River and Fort Pelly on numerous occasions from July 27 through mid-August, and then virtually daily until early September.

August 15: The weather overcast raining for the greatest part of the day. Continued rains for some time past made the waters of the River rise five feet above the usual height. (Fort Pelly Journal [Swan River House], HBCA B.159/a/8 1824-25)

August 18: The weather overcast, some rain at intervals and the waters of the river continue rising so much, that they nearly reach the top of the bank... (ibid)

September 2: The weather continues wet, which has caused the River to raise considerably. (Red River Journal B.235/a/6 1824/25).

Rain was reported at Red River on 11 days between September 1 and September 16, most commonly described as "heavy" (ibid). After a month of "fine" and "mild" weather, winter conditions began in mid-October.

October 16: The snow that fell last night remained, and the weather continued cloudy and cold. (Fort Pelly Journal, op. cit.)

October 19: the ground is now entirely covered with snow and there was some ice along the [Red] River side this morning. (Red River Journal, op. cit.)

October 28: The Red River runs full of drifting ice, and the Assiniboine set fast last night.- Cold weather. (ibid)

In November, temperatures alternated between "cold" and "mild". Snow (and occasionally rain) fell on many days in November and December and began to accumulate in significant quantities in mid-January.

January 12: Last night had a great fall of snow which continued the whole day...The weather continued snowing, in such a manner that it fell better than a foot deep. (Fort Pelly Journal, op. cit.)

January 16: The snow accumulated very much it having snowed the whole night. (ibid)

January 16: Snowed and drifted during last night and the greater part of this day. (Red River Journal,

op. cit.)

During most of January and February, cold weather alternated with thawing conditions. The latter became especially common in early March and spring set in early.

March 6: The people of the fort employed for a short time in the Morning draining the water caused by the melting of the snow out of the yard. (Red River Journal, op. cit.)

March 7: Owing to the late warm Weather a great portion of the snow on the ground is melted, and the Creeks are now all in consequence, running full of water. (ibid)

March 10: Mr. Hargrave returned from Bas de la Riviere...by whom we are informed that several parts of the [Red] River is broken up. (ibid)

March 15: ...the track was so extremely bad that I was obliged to leave my horse and Cariole at a Settler's house, and wade through water...on the surface of the ice [probably on the Red] to the depth of eighteen inches during the last three miles. (Jones, op. cit.)

March 17: ...the Buffalo in consequence of the late warm weather, having moved far out onto the plains...Weather mild Wind South. (Red River Journal, op. cit.)

The last week of March was cold but thawing conditions returned in early April.

April 3: Numerous flocks of ducks and geese were seen this day flying northerly-Warm weather-Wind South. (ibid)

April 7: Swans and Geese are passing flies are numerous and the snow melting fast. The weather clear very mild and calm. (Fort Pelly Journal, op. cit.)

April 10: The ice in the [Red] river is now so weak as to render it dangerous to walk upon it...The greater part of the snow is melted off the plains and the cattle can consequently now easily provide for themselves out of doors. (Red River Journal, op. cit.)

The rise in water levels (described above) began on April 12-13, rather earlier than for most floods on the Red River. Temperatures were very warm and the weather clear until April 25 when heavy rains fell until the 27th. These rains appear to have been widespread, being reported from both Red River and Fort Pelly. From late April through the flood peak (about May 14), the weather was generally warm and dry. The second rise in late June and thereafter was caused by rainfall.

STATE OF THE ASSINIBOINE:

The comments above indicate that the floods on the Assiniboine were relatively as severe as on the Red.

SUGGESTED MAGNITUDE:

Some comments during the 1826 flood indicate that the peak stage in 1825 was

approximately bankfull or slightly greater in the Winnipeg area, flooding the lowest regions adjacent to the river.

> May 3, 1826: The ice in the Rivers has attained the height that the floods reached at the highest pitch last summer, and the water in several places has overflowed the banks and many houses are surrounded thereby. (Red River Journal, op. cit.)

> July 5, 1826: The waters are now nearly within the banks of the River in every part, and are just at the height they were last year, at the highest, and even then they were uncommonly high. (ibid)

In February of 1826, 3 months before the great flood of 1826, Provencher was already worrying about the long term fate of Pembina because of the flooding that had occurred in 1825 (and possibly 1824).

> February 3, 1826: I do not know what will be decided with regard to the re-establishment of Pembina, but I should prefer that Mr. Halkett's plan be followed, because the post is too distant and is generally flooded in years of high water, which is not the case either here or at Whitehorse Plain... (Bishop Provencher [St. boniface] to Bishop Plessis [Quebec City], dated Feb. 2 and 3, 1826, in Nute, G. L. (ed), 1942. Documents Relating to Northwest Missions. Minnesota Historical Society, Saint Paul, Minnesota, p. 439-440)

It is difficult to reconcile the mild winter and early spring with the flood implied by entries such as those for April 26 and May 3 above.

However, the spring flood was apparently of considerable magnitude at Pembina and overbank in the Red River Settlement, indicating a discharge probably greater than 1966; given the high state of the Assiniboine, it may have approached 1950 magnitude.

1826

RED, ASSINIBOINE

Spring

This was, of course, the flood of record in the Red River valley. The basic sequence of events as described in the archival record is presented below to permit comparison with other historical flood events. Further detail, particularly relating to daily weather and specific elevations subsequently recorded by Sir Sanford Fleming can be found in the study carried out by the Red River Basin Investigation after 1950, reported in:

Canada Department of Resources and Development, 1953. Report on Investigations into Measures for the Reduction of the Flood Hazard in the Greater Winnipeg Area: Appendix B, History of Floods on the Red River. Water Resources Division, Red River Basin Investigation, 106 p.

Particular attention will be paid to the conditions in the Assiniboine Basin since these were not reported in the "Report on Investigations..."

April 24: Rivers much Swollen the water running on the Ice which has not moved yet. (Fort Pelly Journal, HBCA B.159/a/9 1825-26)

April 27: Thawed partially during the day in situations exposed to the rays of the sun and sheltered from the strong N.W. Winds...The plains, or pasture ground, begin to bare of snow... (Red River Journal, HBCA B.235/a/7 1825-26)

April 29: ...the Ice in the Red [Assiniboine] River beginning to move the River much Swollen. (Fort Pelly Journal, op. cit.)

April 30: Very few could attend church this morning owing to the thaw having filled the creeks which intersect the plains with water. (David Jones Journal, 1825-26, PAM CMS 18 A92)

May 1: We often wished, and prayed, for warm weather, now this is sent to us, and it turns out a cause of the most serious apprehension; the prodigious quantity of snow which fell during the winter has been dissolved so fast as to cause the river to swell with unusual celerity. Every creek pours in its tributary flood and the water has already overflowed its banks in many places, though there is scarcely any diminution of the snow in the plains around. The ice has not yet moved though elevated nearly up to the level of the banks and it is unusually weighty being in general Four feet thick: in consequence the houses, which are set on the edge of the river are in the greatest danger of being swept away. (ibid)

May 1: the Ice Still strong in Red [Assiniboine] River. (Fort Pelly Journal, op, cit.)

May 1: ...showers of snow, sleet and rain throughout the day-The ice in the Rivers begins to rise in consequence of the flush of waters pouring into them from the plains and mountains, caused by the melting of the snow. (Red River Journal, op. cit.)

May 3: The river rose six feet last night perpendicularly, several tents are now pitched upon the most elevated spots: terror is strongly depicted on every countenance. Several people have taken refuge about the Church...on account of its being the most elevated spot in almost the whole Settlement.

A vast deal of property is now depositing on and about the Mission Premises preparatory to the desertion of houses expected to take place to morrow should the waters continue to increase. p.m. The ice has just started towards the lake; the water keeps rising most alarmingly. Eight feet more will bring it to the elevation of the Church. The weather is stormy in the extreme; the wind blows very high from the North, accompanied with sleet, hail and driving snow. Thermometer...stands all this day at 5 degrees below freezing point. (Jones Journal, op. cit.)

May 3: The ice in the Rivers has attained the height that the floods reached at the highest pitch last summer, and the water in several places has overflowed the banks and many houses are surrounded thereby. (Red River Journal, op. cit.)

May 4: No apparent sign of deliverance yet, last evening when the ice started, the river slackened considerably; but rose again in the morning. The ice continued stationary all this day...The water is now within 4 feet of the Church & also of our dwelling house. (Jones Journal, op. cit.)

May 4: The water in the Rivers rose about 5 feet perpendicular during the last twenty-four hours, and the ice is now on a level with the highest banks, but it is still so thick and strong that even the present flush of waters have not sufficient force to break it up-Sleet rain and snow. (Red River Journal, op. cit.)

May 5: The prospect around us is still more melancholy than ever this morning. All the arable land is now under water and where according to the season of the year the plough ought to be at work the waves roll by the agitation of a piercing north-wind. On a point of the river above us four horses & a barn were swept off by the force of the ice and the ruins floated past us to-day on the surface thereof. Sixty three persons sleep with us to night and to morrow I expect as many more will take refuge here...the ice is uncommonly weighty being generally four feet & a half thick. The force of it is inconceivable the loftiest elm trees are carried away like the most inconsiderable things. (Jones Journal, op. cit.)

May 5: About 2 P.M. the ice in the Red River at length broke up in an awful rush, carrying away cattle, houses, trees and every thing else that came in its way- The river overflowed its banks every where, and carried the ice with great velocity to a greater distance from its course, than had ever been before seen by the oldest inhabitants. The houses of the Settlers were one instant seen standing, and the next not a vestage was to be discovered, to denote their situations. Forty-seven dwelling houses were thus carried off by the first rush, in the short space of half an hour, and many others afterwards from which the wretched inhabitants, barely escaped with their lives. The waters at the same time rushed into the forts, but the banks being fortunately high, the ice only rubbed against the corner of our front bastion. The forts were also guarded by trees on the Assiniboine point. Apprehending an inundation we had previously taken the precaution to raise all the perishable goods and property in the stores, some distance from the ground. This necessary task occupied all hands during this morning and the whole of yesterday. On the floods entering the forts, the families, and part of the people of both establishments were moved out to an elevated situation above the forts, on the Assiniboine, and the rest of the people were placed to take care of the property in the forts. (Red River Journal, op. cit.)

May 6: this day brought us a very favourable change in the weather, but still the waters increase. The number of houses destroyed according to this days report is fourteen: probably many more have shared the same fate, intelligence of which has not hitherto reached us. Ruins of dwellings- parts of Haystacks-packages-boxes etc. are floating down the river...to day a man told me [the Lower Church] was dry- that it was full of people- that he himself had slept there last night. most part of the heavy ice is now gone which must be so far in our favour...The water rose considerably during this day and towards night the wind began to blow and the sky looked wild and dreary. (Jones Journal, op. cit.)

May 6: The waters continued to increase during the last night and this day. The ice during the same time ran past without intermission in immense masses, mingled with the wrecks of houses, fences,

trees, etc. Some of the people of the settlement employed during the day removing their most valuable effects from their dwellings to high situations on the banks of the Assiniboine, amongst the trees; and well was it for them they did so, for before they had fully succeeded, their houses and part of their furniture, were swept off before their eyes by the icy deluge. The havoc was terrible. Boats and canoes were now used in the forts, in passing from one house to another. the clerks and men employed raising all the property higher in the stores than it had been before; the inundation turning out to be greater than at first apprehended. About sixty families with 200 head of cattle enclosed on half an acre of ground, by the floods. Boats sent to give relief. Warm weather with thunder, lightning and rain. (Red River Journal, op. cit.)

May 7: About 4 A.M. the ice in the Assiniboine River broke up, and the waters therein rose as high as those of the Red River. the immense discharge of ice poured in from the former, into the latter mentioned rivers, made the scene as destructive as terrific. The whole population were again in motion, flying to such situations as might afford them a temporary security, leaving in many instances their cattle to perish, and most of their other effects to be swept away; happy in escaping with their lives, Wind variable, with thunder lightning and rain. (ibid)

May 8: The rivers have become almost clear of ice, but the waters increase apace. All the Company's men and boats continue day and night in snatching from watery graves, such of the settlers as were unable to escape from their houses, from the roofs of which, several of them were taken up by our people, with such of their property, as they had saved. Thus repeatedly have the Company been the means of saving the lives of this ill fated people this ill fated year. Cold weather with sleet and rain. (ibid)

May 9: The waters still rose, and the whole country has assumed the appearance of a large Lake. The boats of the fort continue day and night, in use, saving the settlers, with their remaining cattle and effects from destruction. The wrecks of houses are constantly floating down the stream; and the tales of woe from all quarters are really heart-rending. All claim the aid of the fort, the court of which is constantly filled with a flotilla of canoes, imploring the first helping hand. (ibid)

May 10: The scene of desolation and distress in the settlement was if possible, greater this day than yesterday, or before, as the continued rising of the floods, not only increases the alarm, but also the destruction of property. Our boats employed as yesterday. our people encamped without the fort were from the rapid rising of the waters, obliged to pitch further up the Assiniboine River to higher ground. Tempest with darkness, thunder, lightning and rain. (ibid)

May 11: the floods continued to rise considerably throughout the last twenty-four hours, and with the anxiety of the settlers and ourselves for the safety of our lives and property. The remains of houses and fences are constantly floating down the stream. Our boats have been solely employed by the inhabitants in removing their effects up the Assiniboine. All is bustle and confusiion. Tempestuous wind, with thunder, lightning and rain throughout the night. (ibid)

May 13: The water during the whole week has been gradually rising, very few dry spots are now to be seen as far as the eye can reach...About ten o'clock last night the water entered the Church over the threshold of the door, and the appearance presented to us this morning was a sorry one, still we cling to the hope that the river is nearly at its height. An immense number of log houses are floating down through the plains at the back of our premises this morning...(Jones Journal, op. cit.)

May 13: Our people encamped on the banks of the Assiniboine River have been obliged to pitch their camp some miles higher up that stream; their original encampments being overflowed by the rapid swelling of the waters. The forts now stand like a castle of romance in the midst of an ocean of deep contending currents, the water extending for at least a mile behind them, and they are thereby only approachable by boats and canoes. Mr. McKinzie with the few hands he keeps with him in the forts, are obliged to live in the highest stories of the highest houses. The pickets and the chimneys of the houses are falling daily, as well as the plastering of the walls, and even the houses

themselves begin to totter on their foundations. It is really distressing to see such fine complete establishments, thus become, in so short a period, in the condition of a wreck. The settlers were obliged to move still higher up the Assiniboine, for safety, and most of our boats were employed by them as usual in transporting their families, cattle and property to a more secure station than their last retreat. The wrecks of houses still float down the stream without intermission. Tempest with thunder, lightning and rain.

May 14: ...the [Swan] River has overflowed its banks and [the men there] are under great apprehension for the safety of the property. (Fort Pelly Journal, op. cit.)

May 14: Our people were again forced to remove their camp still higher up the Assiniboine, to the vicinity of Sturgeon Creek. The waters rise so rapidly that the property was considered to be no longer safe in the forts, consequently, our people and most of our boats, with the help of some of the settlers, commenced removing the Company's property, with all dispatch, up the Assiniboine to our encampment there. (Red River Journal, op. cit.)

May 16: the current about the buildings was so strong as to make the probability of their destruction amount almost to a certainty. (Jones Journal, op. cit.)

May 16: the whole face of the country, both below and above our encampment is covered with water, and in this windy weather, looks like an immense lake in a storm. Strong S.W. wind... (Red River Journal, op. cit.)

May 17: This morning I was conversing with an old Indian whose tent joined ours when I asked him if he had seen such a flood as this before, he said "No my father, I once saw the site of the Company's Fort an island, but that was nothing to this...Intelligence has just arrived from Brandon House which states that the country is all a sea between the sources of The Assiniboine and The Missouri; and that the waters of the latter are now passing by us to the Lake Winnipeg. (Jones Journal, op. cit.)

May 17: The waters rise at the rate of two feet in twenty-four hours, but at our encampment we have still an elevation of six feet, the highest situation except one, within many miles... (Red River Journal, op. cit.)

May 17: Stormy weather the wind blew from all points of the compass-some thunder and rain...[Buffalo are] now within two Days march of us but the water is so high that it is impossible to get to them some rain in the after noon. (Fort Pelly Journal, op. cit.)

May 18: Mr. Cochran...was overtaken in a violent storm on his return. Indeed the weather has been particularly severe since we were driven from our houses...the water was eight feet deep in the Church to day; but we were glad to find that it had only risen one inch above a mark I made on the casement of the window yesterday. (Jones Journal, op. cit.)

May 18: The water continue to rise at the rate of ten inches in the space of twenty-four hours. The people and almost all the cattle were safe with us, everywhere else, throughout the settlement.. Our camp assumes a regular appearance. We have the waters in front, and the land about Sturgeon Creek in the rear. However, some of the people being yet in terror from the rapid rise of the floods, have moved some miles from us. (Red River Journal, op. cit.)

May 19: The water rising at the rate of four inches in twenty-four hours... Some freemen from beyond Pembina also arrived and report the waters to be as high there as here. High winds during the day, with a dreadul storm of rain, thunder and lightning at night. (Red River Journal, op. cit.)

May 20: Some freemen arrived from the upper part of [the Assiniboine] river, and report that the waters in that quarter are as high as with us. The Missouri River it appears by their accounts, has

overflowed its banks, so as to drive part of its waters this way. They also say that a number of the natives of that quarter have been drowned in consequence. The waters continue rising. Strong North West wind, with thunder, lightning and rain. Almost all the buildings throughout the settlement carried off by the floods and high winds. Many of them containing property. (ibid)

May 20: we were considerably encouraged this morning by hearing that the river had fallen considerably at Pembina; we were confirmed in this hopeful information from the water being almost stationary in both our rivers since last night. (Jones Journal, op. cit.)

May 22: The inundation seems to have reached, at length, its extreme height, it being imperceptible, whither the water rose or fell during the last thirty-six hours, and this happy circumstance seems to revive the gleam of hope in the minds of the forlorn community around us, who are attached to the soil, that their case may not yet be altogether desperate. A demeuron was last night drowned, in a creek close to our encampment, when in quest of his cattle...Messrs. McDermot and Nolin arrived at our camp from Pembina in a boat....They state the waters to be falling there, the effects of which we expect soon to experience at this place. (Red River Journal, op. cit.)

May 22: We were much comforted this morning in finding that the Main River has lowered two inches during the night. The wind continues to blow very furiously... (Jones Journal, op. cit.)

May 23: The happy discovery was made this morning and hailed with joy by the anxious multitude, that the water had fallen two inches during the last night. This long wished for circumstance seems to bring relief to the minds of all. Sultry weather in the morning, in the evening thunder, lightning, and rain. (Red River Journal, op. cit.)

May 24: Went to see the buildings in the morning; everything appeared gloomy in the extreme; the waves ran very high above the premises...(Jones Journal, op. cit.)

May 25: ...the water had fallen three inches. We then pulled over the lands and sites of the settlers houses, and found all covered with no less than ten or twelve feet of water... (ibid)

May 25: thunder lightning and rain towards evening...The water fell three inches last night at our encampment. (Red River journal, op. cit.)

May 27: The waters fall at the rate of 10 inches in twenty-four hours. Warm windy weather. (Red River Journal, op. cit.)

May 29: fine weather to day...the roads are impassable the carts are often aflote & the water & mud continually up to the knees [en route to Swan River]. (Fort Pelly Journal, op. cit.)

May 30: Considering now that the Church was out of danger, the water having fallen altogether 2 feet 5 inches. (Jones Journal, op. cit.)

May 30: march very slow owing to the high state of the water...Rained very much all Day the weather most stormy [en route to Swan River]. (Fort Pelly Journal, op. cit.)

May 31: [Swan] River...[was] a most dismal looking place the water having washed away all the [houses]...rained much all Day. (ibid)

May 31: The floods fall at the rate of one foot in twenty-four hours, but makes, at a general view, little appearance of diminution, owing to the great extent of our country inundated. The settlers seeing at length the improbability there is of their cultivated lands drying sufficiently soon to enable them to secure seed for the ensuing year, have consequently commenced breaking up new ground. where such is to be found dry, in which they plant small quantities of wheat, to prevent its becoming once more extinct in the settlement. A man and three children were drowned this morning in the rapids

above the encampment...the current runs with such velocity, that what once falls into it, it is in vain to attempt to recover. About noon we experienced a heavy storm of thunder, lightning and rain; after which the weather became more than usually pleasant. (Red River Journal, op. cit.)

June 3: Since the last date...the weather has been very boisterous: last night tho the house stands only two feet in water, the waves dashed against the roof most part of the night. (Jones Journal, op. cit.)

June 4: Early this morning I waded through the swamps between the house and the encampment...The excessive heat of the sun together with the mosquitoes prevented us from enjoying...the services. (Jones Journal, op. cit.)

June 6: All hands continued fitting out our boats. The water falls at the rate of one foot in twenty-four hours, at our encampment, though it is said to exceed six inches about the Forks, where it is more expanded. Rainy weather, with a strong S.E. wind. (Red River Journal, op. cit.)

June 12: We are now nearly re-established in our dwellings...The ploughs are at work to-day...The people are now drawing near the banks of the river to the site of their old habitations. (Jones Journal, op. cit.)

June 13: The water continues falling at the usual rate. (Red River Journal, op. cit.)

June 22: The settlers still continuing putting seed in the ground in proportion, as the waters withdraw from their cultivated lands, but of which a very small part is yet dry. Wind N.W. blowing a strong gale. (ibid)

June 24: Continued our voyage up the River towards the fort, but made slow progress, owing to the great force of the current. (ibid)

July 3: Most of the farms are now clear of water...(ibid)

July 4: The waters continue to fall regularly at the rate of one foot in twenty-four hours, and are now getting within the banks of the Rivers in most parts. Vegetation is uncommonly rapid. Crops appear above ground the third day after being planted, which is no doubt owing to the moisture of the ground and the heat of the weather. (ibid)

July 5: The waters are now nearly within the banks of the River in every part, and are just at the height they were last year, at the highest, and even then they were uncommonly high. The people of the settlement employed enclosing their farms, and building new houses, with as much energy as if no misfortunes had ever befallen them. (ibid)

The prodigious spring runoff and continued high water in the late summer and fall produced exceptionally high water levels in Lake Winnipeg.

October 11: [Mr. Nolin] states that the waters in Lake Winepeg are higher than ever known to be at any former period. The islands therein he says are entirely under water as well as all the head lands of the coast. (ibid)

ANTECEDENT CONDITIONS:

The 1826 exhibited most of the classic preconditions which typically lead to large floods.

The heavy rainfall in August and September of 1825 (see above) saturated the ground and in late September, both the Assiniboine and Red Rivers were rising:

> September 23: ...owing to the late heavy rains, both Rivers have risen considerably. (Red River Journal, HBCA B.235/a/6 1824/25)

As Alexander Ross wrote in his classic description of the flood:

> The previous year had been usually wet; the country was thoroughly saturated. The lakes, swamps, and rivers at the fall of the year were full of water; and a large quantity of snow had fallen in the proceeding winter (Ross, Alexander, 1856 (reprinted 1972), The Red River Settlement, Its Rise, Progress, and Present State, Ross and Haines, Inc., Minneapolis, Minnesota, p. 106).

The weather at the end of September and the first week of October was warm but cold weather set in early with snow alternating with rain in the Red River Settlement throughout much of October. Freezeup of the Assiniboine began on October 28 but subsequent mild weather melted the ice and complete freezeup was delayed until early November.

> November 6: Blew a strong gale from the East, during last night and this morning, with very heavy snow-Ice drifting in both Rivers. (Red River Journal, op. cit.)

> November 7: Wind and weather continued as boisterous as yesterday-The Assiniboine River set fast last night, and the Red River, continues to run full of drifting ice. (ibid)

> November 9: Last night the Red River set fast, and the inhabitants this day crossed upon the ice. Weather more moderate than yesterday. (ibid)

Snow and rain continued to fall over the following week:

> November 13: Weather warm with a strong gale of Wind from the North West - Much rain with Thunder and lightning in the afternoon; an extraordinary circumstance at this season of the year. (ibid)

> November 15: Snowed last night and all this day. (ibid)

Severely cold and unusually mild weather alternated until mid-December when cold weather with periodic snow was reported almost continuously until the end of January. In a letter dated February 2 and 3, Provencher wrote:

> The winter began early and has been very harsh both with stormy weather and cold. (Bishop Provencher [St. Boniface] to Bishop Plessis [Quebec City], dated February 2 and 3, 1826, in Nute, G.L. (ed..), 1942. Documents Relating to Northwest Missions. Minnesota Historical Society, Saint Paul, Minnesota, p. 439-440)

In February, the weather again became periodically milder, with snow and rain alternating.

> February 10: Cloudy & boisterous with a little Snow this Evening we had a copious Showr of Rain rather a novel thing this time of Year. (Fort Pelly Journal, op. cit.)

February 11: very boisterous-the quantity of Rain last night was very great. So much So that it has formed a very Strong crust on the Snow. (ibid)

February 11: Snowed and drifted most part of the day-The snow now round the fort as high as the Pickets- and twice as much on the plains as at any time last winter. (Red River Journal, op. cit.)

March was generally reported as cold, with frequent snow.

March 2: The weather continues unusually cold and stormy, there is every prospect of a late spring. (Jones Journal, op. cit.)

March 2: Snowed and drifted all last night and this day-The snow this season is unusually deep-many houses in the Settlement are actually burried under it. (Red River Journal, op. cit.)

March 15: Snowed and drifted during the last night and all this day. (ibid)

March 17: the Snow continued to day and all this night. (Fort Pelly Journal, op. cit.)

March 18: A Great fall of Snow. (ibid)

Thawing weather did not begin until late March and did not become general until mid-April. Even then, however, it was interrupted by periodic return to cold weather.

March 29: The weather, for the first time this season, was so warm about noon, as to melt the snow in front of the fort, but the thaw in the plains was scarcely perceptible. (Red River Journal, op. cit.)

April 1: No general thaw this day, though a partial melting of the snow, was perceived in places exposed to the rays of the Sun and sheltered from the Wind which blew a strong gale from N.W. (ibid)

April 12: Thawed from 10 A.M. until sun set-Wind S.-This is the first general thaw we have had this season. (ibid)

April 14: Great and General thaw to day the Snow melting rapidly. (Fort Pelly Journal, op. cit.)

April 17: Snowed and froze keenly during last night and all this day, with a strong North Wind. Red River Journal, op. cit.)

April 19: Clear cold weather with North wind, and has certainly more the appearance of January weather than that of April- More snow has fallen during the two days past, than previously thawed of the original winter stock. (ibid)

April 21: No thaw, in the shade-but a partial thaw in places exposed to the rays of the sun. (ibid)

On April 24, the Assiniboine River was reported as "much swollen" and the subsequent buildup to the flood is reported above.

STATE OF ASSINIBOINE:

From the descriptions above, it is clear that the Assiniboine basin was as severely

affected as the Red. The descriptions from Fort Pelly suggest that conditions may have been as severe as in the floods of 1974 and 1976, with a peak of the order of 30,000-50,000 cfs at Portage la Prairie.

FLOOD MAGNITUDE:

The discharge of the combined Red and Assiniboine Rivers has been calculated as 225,000 cfs (Canada Department of Resources and Development, 1953), the largest known flood in the basin.

1827

RED

Spring, Summer

The 1827 event was similar (although probably of lesser magnitude) to the 1825 flood in that it seems to have had both spring and summer peaks.

April 8: The river is swelling very rapidly and the people are very uneasy. (David Jones Journal, PAM MG7 B2 CMS A92)

April 8: Warm weather in the forenoon. Wind S. In the evening the wind veered to E. and was followed with heavy rain, the first one of the Season. Geese, Ducks and Swans flew past in considerable numbers towards the North. Snow nearly all melted. Rivers rising rapidly. (Red River Journal, HBCA B.235/ε/8 1826/27)

April 9: Rained throughout last night, but cleared up in the morning, and continued fine weather all day. Wind E. The river rises apace. (ibid)

April 11: In proportion as the water rises the anxiety & fear of the people rise too. (Jones Journal, op. cit)

April 14: The water swells very alarmingly to day. (ibid)

April 14: The ice in the big [Red] river moved a short distance the water therein rising rapidly. (Red River Journal, op. cit.)

April 15: While we were at Church, the ice started. The water is about stationary. (ibid)

April 16: This evening the ice in the Red River broke up and passed down with great velocity. The water rose so high as to cover some of the low lands along the river. (ibid)

April 17: The big [Red] River now runs open, but the Assiniboine is still fast. (ibid)

April 18: ...about four o'clock in the morning the main body of ice passed down, and the river fell a little...we were happy to find only one family driven out of their house by water. (W. Cochran's Journal, PAM MG7 B2 CMS A85)

April 22: Very cold; the wind blew from the north; the river rose considerably and began to wear a threatening aspect. (Red River Journal, op. cit.)

April 24: cold; the wind blew from the north and the [Red] river continued to rise which increased the creeks to such a prodigious height that it was with great difficulty that I could get through them. I was obliged to go about two miles out into the plains to pass the ends of them, where the water flows out of the swamp. (Cochran Journal, op. cit.)

April 25: very cold and the river continued to rise. (ibid)

April 26: The big river rises at the rate of four inches in the twenty-four hours. (Red River Journal, op. cit.)

April 29: fine weather, the River continued to rise and approach near some of the houses. (Cochran Journal, op. cit.)

April 30: Some of the farms on low grounds are now under water from the swelling of the rivers, and the owners of such have been obliged to abandon their houses in consequence. But such of the settlers whose lands are on high situations have commenced ploughing. (Red River Journal, op. cit.)

May 1: The Red River continues rising. Part of the ice in the Assiniboine River broke up and drifted down the stream. A few of the settlers sowed wheat on their high lands, and the labours of the season may be said to have commenced actively by all. (ibid)

May 2: The ice in the Assiniboine River broke up entirely, being forced away by the flush from bank to bank. (ibid)

May 3: Both rivers continue rising at the rate of three inches in twenty-four hours and spread rapidly on the low grounds. (ibid)

May 4: Thanks be to God the river is now stationary and no probability of further increase of water. there have been a few families dislodged and the good soil on the lowest ground is now partiially inundated but we trust it will soon dry. (Jones Journal, op. cit.)

May 5: the waters seem to be at their height having neither risen nor fallen during the last twenty-four hours, which happy circumstance has relieved the poor settlers from much anxiety as they were greatly alarmed least a recurrence of last years disasters would befall them. (Cochran Journal, op. cit.)

The weather in late May and June was extremely hot and dry.

June 5: the weather was exceedingly hot the air was like the steam of a furnace...the heat was so excessive that I could with difficulty breathe [in the Church]. (ibid)

June 15: Rained a little during last night, which was much required, the crops being much parched by the late long continued drought...(Red River Journal, op. cit.)

June 16: Last night a hoar frost fell, which done much injury to the crops. (ibid)

June 27: exceedingly hot and dry; the corn and potatoes were scorched by it, and began to wither very fast. The earth was heated to such a degree by the rays of the Sun and the long drought, that it appeared almost impossible for vegetation to exist. In many places there was no moisture in the ground four inches from the surface. About noon, I digged a hole in our garden six inches deep and put the Thermometer in it and covered it over with earth, which I dug out of the hole, and let it continue for half an hour, when I took it up, I found the quicksilver standing at 90° Fahrenheit. (Cochran Journal, op. cit.)

Frequent and abundant rain returned in July and produced a second peak in the river.

July 7: The Settlement has been blessed with daily showers of rain, for some days past, and the crops in consequence are improving rapidly. Mosquitoes in clouds since the moist weather. (Red River Journal, op. cit.)

July 13: The weather of late has been very pleasant accompanied with nourishing showers of rain...Mosquitoes almost unsupportable. (ibid)

July 31: We have had daily showers of rain for the last ten day[s] which greatly improves the crops

but retards the haymaking. (ibid)

August 9: This morning we were visited with an awful thunder storm, which lasted for two hours, during which time the rain fell in torrents, and the firmament was in one continuous blaze- We have had several thunderstorms of late, but none so terrific as this. (ibid)

August 31: Since the 14th scarcely a day has passed without heavy rains, a circumstance of serious consideration to the inhabitants, and their crops are in part rotted on the ground. (ibid)

September 20: Not a day passes without heavy rains...The Rivers are greatly swollen by the late rains, as much so, as after the ice went off in the spring and it is even a difficult matter to go on horseback from one end of the Settlement to the other, the face of the country is so entirely covered with water. (ibid)

September 30: Scarcely a dry day has been experienced since the last date... (ibid)

Very high water was reported as late as November 5.

November 5: Most of the snow has been melted off the ground within these last few day[s], which together with the water previously on the ground has laid the plains under an entire sheet of water and greatly swollen the Rivers. (ibid)

ANTECEDENT CONDITIONS:

After the severe flooding of the spring of 1826, considerable and frequently heavy rain was reported in August and September.

August 15: the weather was exceedingly cold and wet; the rain fell in torrents the whole day...The hay which we had cut was covered with water. (Cochran Journal, op. cit.)

September 9: Cold and rainy...I set out for the lower [church]; the rain pouring in torrents upon me. (ibid)

September 23: The wind blew tempestuously, and the rain fell in torrents... (ibid)

September 24: the late heavy rains have left little hope of the late barley crops or any of the wheat ever ripening... (Red River Journal, op. cit.)

October was generally mild with periodic rain. The first significant snowfall occurred on November 1 but was removed by subsequent mild weather and rain:

November 1: Snowed heavily towards evening with a strong gale from the S.E. (Red River Journal, op. cit.)

November 2: Snowed all day. (ibid)

November 3: Heavy rain throughout the day which dissolved all the snow that fell during the two days preceding. (ibid)

November 4: Rained incessantly during all last night and this day, which together with the late melted snow has swollen the rivers and laid the country under one general sheet of water. (ibid)

The mild weather continued throughout November and the first half of December. Freezeup of the rivers didn't begin until mid-November and wasn't complete until late in the month.

> November 25: The ice in the Red River has been setting fast by degrees since the 20th Inst. and is now sufficiently strong in all parts, to admit of foot passengers crossing upon it without risk. (ibid)

> December 3: Snowed during last night and all this day. The ground is covered with it about 4 inches deep, which was until now bare. (ibid)

> December 15: Snowed heavily last night, and this day with a strong N.W. wind. It was the only real severe winter weather we have had this season, which is proof of its being a remarkable mild winter so far. The inhabitants after housing their livestock for the season, in the latter part of October, were induced by the late continuance of mild weather, to let them out to graze again in the plains, where the[y] have provided for themselves for a month past and thereby saved the farmers much of their fodder. (ibid)

From December 15 to mid-January, the weather was generally cold with periodic snow and drifting. Mild weather returned from mid-January to early February.

> January 31: We hope not to have such a flood this year; there is not so much snow and the winter is much milder. (Bishop Provencher [St. Boniface] to Bishop Plessis [Quebec], dated January 31, 1827 at St. Boniface, Red River, in Nute, G.L. (ed.), 1942. Documents Relating to Northwest Missions. Minnesota Historical Society, Saint Paul, Minnesota, p. 445)

The remainder of the winter alternated between cold and mild with no indication of exceptional snowfall. Thawing weather began toward the end of March and continued into early April when river stages began to rise.

> March 31: this is the first day of genial thaw, the spring is getting very late and this makes the people dread another flood...The past winter has been very mild until this last fortnight; during which time it has been in the other extreme. (Jones Journal, op. cit.)

> April 1: Thawed during last night and this day. The plains in many places clear of snow-and a great deal of water on the ice in the rivers. The quantity of snow has been this winter but trifling in comparison with that of last year. Geese and ducks seen for the first time this Season. Wind S. (Red River Journal, op. cit.)

> April 2: The wind during last night veered to the North West, which as usual produced a change of weather for the worse, there following showers of snow with high Winds. (ibid)

> April 6: Thawed a little about noon. Wind S.W. The Cattle of the Settlers grazing at large in the plains. (ibid)

> April 8: the river is swelling very rapidly and the people are very uneasy. (Jones Journal, op. cit.)

STATE OF THE ASSINIBOINE:

No information exists from sources on the Assiniboine and there is nothing in the records from the Red River Settlement to indicate that the Assiniboine was unusually high.

ESTIMATE OF MAGNITUDE:

The river appears to have been at or slightly above bankfull in the Red River Settlement, with some flooding of low areas. For this to have occurred as far downstream as below the Forks would suggest discharge of about 1966 magnitudes.

1828

RED

Spring

This event was the fourth flood year in succession.

April 22: During the past week the thaw has been rapid and yesterday the ice gave way at Frog Plain. This evening we have smooth water, the water is again high & many people uneasy. (Jones Journal, PAM MG7 B2 CMS A92)

April 25: The Red River is entirely clear of drifting ice, but the Assiniboine still runs full of it...The plains are now entirely clear of snow. (Red River Journal, HBCA B.235/a/9 1827/28)

April 28: Some have already sown wheat on ground ploughed last autumn...The Assiniboine point is now overflowed as are also most of the low points along the Big River. (ibid)

April 30: ...The rivers still on the rise. (ibid)

May 5: this day is more stormy than any I have seen since the commencement of winter; it blows a storm from the North with a tremendous drift and winter scenery seems to have set in again completely. (Jones Journal, op. cit)

May 19: The rivers continued to rise until a few days ago, and were more swollen this spring, than during any season in latter times, that of the great floods excepted. The waters are now receding from the flooded lands and as the soil drys, the seed is planted. (Red River Journal, op. cit.)

May 31: The rivers have fallen rapidly of late, and are now within their natural limits, and the land overflowed by them is now under crop... (ibid)

June 18: Nous avons passe l'hiver assez heureusement. L'eau est montee encore beaucoup, mais n'a pas noye les terre de St. Boniface. Pembina et audessus a ete submerge c'est laquatrieme anne desuite. tout le monde a seme avec ardeur, le grain a bonne apparence. (Msg. J.N.Provencher, Eveque de Juliopolis, a Msg. J.I.Lartigne, Eveque de Telmesse, dated Riviere Rouge, 18 juin, 1828, PAM MA MG7 D1)

ANTECEDENT CONDITIONS:

The wet conditions in the fall of 1827 were described under 1827 above.

September 20: Not a day passes without heavy rains...The Rivers are greatly swollen by the late rains, as much so, as after the ice went off in the spring and it is even a difficult matter to go on horseback from one end of the Settlement to the other. (Red River Journal, op. cit.)

September 30: Scarcely a dry day has been experienced since the last date...(ibid)

Significant snow fell in late October but melted soon after.

October 28: Snowed all last night and this day heavily, being the first fall of the season. (ibid)

October 31: The weather continues snowy & boisterous with only a partial thaw in the day-time. (ibid)

November 5: Most of the snow has been melted off the ground within these last few day[s], which together with the water previously on the ground has laid the plains under an entire sheet of water and greatly swollen the Rivers. (ibid)

Cold weather began in mid-November and continued without a reported break until late December.

November 17: Both Rivers set fast last night opposite the fort, but are still partially open below it...The weather of late has been generally cold with snow showers... (ibid)

November 29: I could not attempt more yesterday as it snowed very heavy all the day but as it cleared up this morning, I started [for Fort Alexander from Netley Creek]...very much fatigued from walking in Snow up to my knees every step. (George Taylor's Journal, HBCA B.235/a/11 1827/28)

After mild weather in late December, cold returned until early February when it began to alternate with mild periods. From mid-February until the end of March, the weather was most commonly reported as mild.

February 29: The weather of late has been unusually mild for the season-thawed about noon for the last ten days. (Red River Journal, op. cit.)

March 15: The weather has ever since the beginning of the month been remarkably mild, even so much as to cause a partial melting of the snow about noon in southern aspects. (ibid)

March 31: The weather keeps remarkably fine, and thaws a little about noon daily. (ibid)

April 2: Weather so warm as to melt the snow during the whole day. (ibid)

Nevetheless, colder weather must have returned in early April for on April 10 David Jones reported

April 10: The spring is very late; during the last two or three days the weather is a little warm; but the none [sic] appearance of any water fowl shows that spring is not yet commenced. (Jones Journal, op. cit.)

April 13: Snow falling very fast and we feel the severity of winter now more than at any former period of the season. (ibid)

April 19: From the last date to the present, the weather has been cold and boisterous, with heavy falls of snow, but the wind changing this day about noon from the Northward to South, warm weather succeed[s] the cold almost instantaneously. (Red River Journal, op. cit.)

A general thaw commenced after the 19th and the sequence of rising water levels is described above.

STATE OF ASSINIBOINE:

No information exists about the conditions in the Assiniboine basin in 1828, apart from the possible inference that because most of the quotations above use the plural "rivers", the Assiniboine was also high.

SUGGESTED MAGNITUDE:

The river again seems to have been overbank at Pembina and in the lowest areas at least in the Red River Settlement and remained at that level for some time. A discharge of 1948-1966 magnitude seems appropriate.

1829

ASSINIBOINE

Summer

This minor event seems to have been confined to the Assiniboine River. The descriptions of spring runoff are conflicting, reported as high by some entries while others express concern that the water will be too low for travelling. It can only be concluded that the freshet was not particularly unusual.

April 7: [Going to the Rapids in the morning] we got on very well for about 7 miles, afterwards we were involved in great danger, the ice being full of holes. (W. Cochran's Journal, PAM MG7 B2 CMS A85)

April 7: They left their loads on the way for want of snow...Snowed last night. (Fort Pelly Journal, HBCA B.159/a/10 1828-29)

April 8: ...The thaw continued and the river rose considerably. (Cochran Journal, op. cit.)

April 9: The small river overflowing its banks...Snow and Sleet during the night and most part of the day. (Fort Pelly Journal, op. cit.)

April 14: Swan River by the men's report High...weather cold wind SW. (ibid)

April 14: The ice in the [Assiniboine] river broke up-crossed a party of Cree Indians in the evening. (New Brandon House Journal, HBCA B.22/a/22 1828/29)

April 15: Last night the ice stopped down below which occasioned the water to rise very much about Mid day the Ice took its course and the waters lowered. (Red River Journal, HBCA B.235/a/12 1828/29)

April 16: The weather Cloudy & Cold, the Main [Red] River Clear of ice...The Settlers beginning to Plough & some have put wheat in the Ground. (ibid)

April 25: The weather until this day has continued frosty, whereby our ploughing, which operation we commenced on the 20th was at times interrupted...The [Assiniboine] River falls off rapidly, and we are using every effort to...get away before the navigation becomes like difficult as some former year, from the shallowness of the water. (New Brandon House Journal, op. cit.)

April 26: The [Assiniboine] River pretty high... (Fort Pelly Journal, op. cit.)

May 5: Owing to the falling off of the water...we are this morning...embarked. (New Brandon House Journal, op. cit.)

May 7: the [Assiniboine] River is high. (Fort Pelly Journal, op. cit.)

In late May, the weather turned wet with frequent rain reported in the Red River Journal after May 27.

May 27: Had a shower of Rain last Night to day Cloudy in the Evening had a very heavy Shower accompanied with Thunder & Lightning. (Red River Journal, op. cit.)

May 29: Last Night had a heavy Shower of Rain accompanied by Thunder & Lightning...(ibid)

May 30: in the Evening had a very heavy Shower of Rain. (ibid)

June 4: ...in the Evening we had a very heavy shower of Rain which lasted all night. (ibid)

June 6: The morning Rainy...in the afternoon it Blew a Gale & continued part of the night with intermitting showers of rain. (ibid)

June 11: ...in the Evening we had Thunder & Lightning accompanied by a heavy shower of rain. (ibid)

These reports are from the Red River Settlement and are not particularly remarkable. Nevertheless, it is assumed that the rains were widespread (and possibly heavier) in the Assiniboine basin, since by June 12 the Assiniboine in the Settlement was being described as high.

June 12: The morning fine in the afternoon had a Shower of Rain with Thunder owing to the frequent & heavy Rains of late the Assiniboine River is very high and has overflowed the Points... (ibid)

June 17: The weather very windy in the course of the day it Rain'd a little the water is still very high owing to which the People take very few fish. (ibid)

Rain continued to be reported about every other day until the end of June when the stage of the Assiniboine began to fall.

June 28: The weather fine & the water beginning to fall. (ibid)

SUGGESTED MAGNITUDE:

The elevated waters in the Assiniboine due to early summer rains are unusual and suggest heavy rainfall upstream but the event itself does not seem particularly significant.

1830

ASSINIBOINE

Spring

This event on the Assiniboine seems to have been more severe than that of 1829, beginning as a snowmelt freshet but being increased by heavy rainfall in late April and May. As with 1829, there is no indication that the Red River was affected.

April 11: The water rose very much during the Night to day the ice made a General move in consequence the water fell very much in the evening the River was free of ice. (Red River Journal, HBCA B.235/a/13 1829/30)

April 16: fine Weather snow fast diminishing a considerable quantity of water on the ice. (Brandon House Journal, HBCA B.22/a/23 1829/30)

April 18: Weather extremely warm the snow has entirely disappeared as if by Majic [sic] and the [Assiniboine] River broke some distance below. (ibid)

April 20: Stormy weather with rain the [Assiniboine] River nearly clear of ice. (ibid)

April 22: The weather fine but Cold Wind North the Assiniboine is now clear of ice. (Red River Journal, op. cit.)

April 24: Weather cold wind northly...[the roads] being at this date blocked up in several places with large drifts of snow. (Fort Pelly Journal, HBCA B.159/a/11 1829-30)

April 25: Cold Weather the [Assiniboine] River has since morning risen upwards of three feet. (Brandon House Journal, op. cit.)

April 26: Stormy weather with Snow...[Assiniboine] River still rising upwards of six feet since yesterday. (ibid)

April 26: the Road in Several places is not clear of drifts. (Fort Pelly Journal, op. cit.)

April 27: the weather fine but Cold the wind North. The Assiniboine River is very high and overflowed some of the Points. (Red River Journal, op. cit.)

April 28: Weather mild wind South...The [men?] returned in the evening from the High state of the watters we Launched the Boat. (Fort Pelly Journal, op. cit.)

May 4: [A man] returned this evening and reports that Swan River is high. (ibid)

May 5: the watters being to[o] High...Weather warm and sultry. (ibid)

May 6: we Had a Heavy fall of rain after 12 noon for the remaining part of the day. (ibid)

May 7: watter raising daily. (ibid)

May 8: The High state of the [Assiniboine] River has prevented many of the Indians from coming to

the Fort. (ibid)

May 10: Heavy fall of rain during the night...the whole country there [Swan River area] is inundated. (ibid)

May 14: Keen frost in the night...The country in our vicinity all overflowed the Red River [Assiniboine] not known to be so Hi in this quarter for many years, it did not overflow its banks Here the Year the Colony was overflowed. (ibid)

May 16: Weather fine and mild...[A man] says the watter is spreading all over the Country. (ibid)

May 17: fine Weather...an Indian came in from Shell River Says the Waters are unusually high. (Brandon House Journal, op. cit.)

May 24: They report that the watter Has fallen several feet [in Swan River]. (Fort Pelly Journal, op. cit.)

This is the final reference to the state of the river. Rev. W. Cochran summarized the extensive rain in May followed by a severe drought in late June and July as follows:

July 29: This Spring the whole of the people in my neighbourhood have suffered severely from the heavy rains which fell in May. In the beginning of May, the rain fell in such abundance that the whole surface of the plains was a sheet of water. This obstructed every kind of Agriculture for upwards of ten days. As soon as the land was so dry as to bear cultivation, the people commenced sowing. The seed time lasted for 20 days, the weather being so dry as to allow us to work upon the ground. After we had sown the wheat and planted the potatoes, the rain fell in such profusion that the ground was perfectly deluged. This continued till it destroyed a large portion of the wheat and most of the potatoes. This is a general calamity in my neighbourhood; about 10 miles further up it has been partially felt. Since the 15th of June, we have had only one slight shower. The ground is now parched with the long continuation of dry weather. (Letter, Rev. W. Cochran to Secretaries, Church Missionary Society, London, PAM MG7 B2 CMS A77, p. 395)

ANTECEDENT CONDITIONS:

The late summer and early fall of 1829 were dry and the level of the Red was reported to be low. Snow fell at both Red River and Fort Pelly in late October, apparently in significant amounts and freezeup of the Red occurred on October 30. Several snowfalls in November and December were reduced by subsequent milder weather.

December 23: Weather particularly Mild Snow diminishing. (New Brandon House Journal, op. cit.)

December 24: walking ankle deep in water in the Fort an unusual thing at this season of the year. (Fort Pelly Journal, op. cit.)

In January, more consistently cold weather permitted the accumulation of significant snowpack from storms late in the month and into February.

February 2: Snowed in the night Wind Nwest and Drift and Snow for most part of the day...the Snow being too deep to Haul [logs] to the Fort. (ibid)

February 11: The weather fine some men who Mr Nolin sent off yesterday for Pembina Returned not being able to Proceed owing to the Quantity of snow. (Red River Journal, op. cit.)

Several strong thaws after mid-February reduced the snowpack somewhat but subsequent frequent snowfalls further increased the depth on the ground.

March 21: We experienced one of the heaviest falls of snow for the winter in Course of last night and all this day...Weather mild. (Fort Pelly Journal, op. cit.)

March 22: [A man] ran down & kiledd on snow shoe a Cross Fox and Wolf such is the depth of snow in the quarter...Weather as yesterday. (ibid)

Strong thawing conditions with rain set in on March 24 and continued to the breakup period in early April.

April 5: Froze hard last night the water [rose] about three feet during the night. (Red River Journal, op. cit.)

April 6: Froze hard last night the weather Cold the man who was sent with the Dispatches to Bas de la Riviere not being able to proceed owing to the quantity of water on the lake. (ibid)

April 7: The weather Cloudy the ice made a move but stoped shortly after, in the Evening it Rain'd a little. (ibid)

April 8: fine Weather snow fast disappearing. (Brandon House Journal, op. cit.)

April 11: The water rose very much during the Night to day the ice made a General move in consequence the water fell very much in the evening the River was free of ice. (Red River Journal, op. cit.)

April 16: fine Weather snow fast diminishing a considerable quantity of water on the ice. (Brandon House Journal, op. cit.)

SUGGESTED MAGNITUDE:

No estimate.

1849

RED

Summer

This flood on the Red was produced by one of the most unusual and best-chronicled summer precipitation episodes in the central Great Plains region. It was not unique, however, and may be compared with the summers of 1806, 1825, 1827, 1850, 1851, and perhaps 1860.

The unusual nature of the early spring and summer weather in the Missouri-Kansas-Nebraska region was analysed by Parker (1964) and Lawson (1974, 1975), based on the accounts left by some 30,000 '49er gold rush migrants on the Oregon Trail.

Parker, W., 1964. Wading to California: The influence of the Forty-Niners on the notion of the Great American Desert. Great Plains Journal, v. 3, 35-43.

Lawson, M.P., 1974. The Climate of the Great American Desert. University of Nebraska Press, Lincoln, Nebraska.

Lawson, M.P., 1975. Meteorological experiences of the Forty-Niners crossing the Great American Desert. Weatherwise, v. 28, 250-53, 271.

These writers showed that the spring of 1849 in the vicinity of the assembly points near St. Louis was unusually cold and late and marked by exceptional rainstorms in May which inundated the plains and greatly swelled the rivers. Rainfall in April and May at Fort Kearny (south-central Nebraska) had exceedence probabilities of only about 1%; at Saint Louis Arsenal and other eastern Oregon Trail sites, precipitation exceedence probabilities were 1% or less from June through August and most stations recorded 200-300% normal precipitation in at least one of these months.

These analyses were extended 1000 km northward into the Red River basin by Blair and Rannie (1994) and Rannie and Blair (1995), based on the accounts of the Woods/Pope Expedition from Fort Snelling (Minneapolis/St. Paul) to Pembina and archival sources from the Red River Settlement.

Blair, D. and W.F.Rannie, 1994. "Wading to Pembina": Spring and summer weather in the valley of the Red River of the North and some climatic implications. Great Plains Research, v. 4 (1), 3-26.

Rannie, W.F. and D. Blair, 1995. Historic and recent analogues for the extreme 1993 summer precipitation in the North American mid-continent. Weather, v. 50 (6), 193-200.

Spring was also late in the Red River Settlement and the ice in the Red River did not break up until May 7.

April 18: At present there is no appearance of the ice going. Horses and oxen, as well as people, still cross the river upon the ice. It may be two or three weeks before the river is open. (J. Smithhurst Journal [at Indian Settlement], PAM MG7 B2 CMS A97)

April 25: It has been snowing and drifting all day and everything looks...much like winter... (ibid)

April 30: today, tho' the last day of April, was like one from January...The Ice is still upon the River, not the voice of one singing bird is heard. (Robert James Journal, PAM MG7 B2 CMS A92)

May 7: Ice first began to drift out so that we at length see open water and canoes crossing the river... (Smithhurst Journal, op. cit.)

The weather improved markedly for the first two weeks of May but deteriorated again in late May.

May 21: The ground is again covered with snow... (ibid)

May 22: Still snow. (ibid)

Temperatures rose soon after but June (and the rest of the summer) were astonishingly wet. The most detailed accounts are provided by the diaries of Captain Samuel Woods and Lieutenant John Pope on the Woods Expedition from Fort Snelling to Pembina. The company left Fort Snelling on June 6 and was immediately confronted by widespread, almost continuous, and frequently heavy, rainfall.

June 6-11: Our starting was unpropitious; the rains commencing on the 4th continued intermittingly until our arrival at Sunk Rapids on the 11th... The rains having fallen so steadily and for so many days. the earth was so saturated with water, that the thickly-matted turf of the prairie would not support the weight of the wagons... The [Sauk River] was much swollen by the heavy rains, and was wide and deep. (Woods, 1850. Report of Major Wood [sic] relative to his expedition to Pembina Settlement and the condition of affairs on the North-Western frontier of the Territory of Minnesota. United States House of Representatives Executive Document No. 51, 31st Congress, 1st Session, p. 10)

June 20: Having awaited the drying of the prairies until the 16th of June, we determined on that day to commence our march for the Red River...we reached a small lake tributary to the Crow River on the 20th of June. The rain falling incessantly... (Pope, J., 1850. The report of an exploration of the Territory of Minnesota. United States Senate Executive Document No. 42, 31st Congress, 1st Session, p. 18)

June 27-July 3: The heavy and incessant rains since the 4th of June had so saturated the prairies... that it was found absolutely necessary to halt for a few days...From...the continuous heavy rains for several weeks previous, the rich black soil of the prairies had become perfectly saturated and many were under the impression that the whole country was swampy, but I was informed by the guides that such a season had not been known for 20 years, and that they had never seen the country in such condition before. (Pope, op. cit, p. 18-19)

July 6: We resumed our march on the 6th of July, but found the prairies so bad from the drenching rains that had just fallen, we were scarcely able to get along. Little drains that usually contain no water, were now almost swimming, and these occurring every mile or two, with the miry conditions of the ground, rendered our march slow and exhausting to our trains. (Woods, op. cit., p. 13)

July 15: The high waters in these rivers [Maple, Rush, Sheyenne] compelled us to depart greatly from the Red River, and we had thus approached very near the dividing ridge between the Red River and Upper Sheyenne. (Pope, op. cit., p. 24)

July 17: Starting at 12 M, over a level prairie on which the water stood from two inches to two feet deep almost the entire way, and after going about fourteen miles, we reached Maple river, which Mr. Kittson had bridged; but the water being much higher now than when he crossed it, the bridge had disappeared... There had been such torrents of rain about this time that the little branches that ordinarily furnish barely a sufficiency of water to allay the thirst of a travelling train were now swimming...About eight miles from Rush river we came upon a little prairie stream much swollen and deep. (Woods, op. cit., p. 16)

Reverend Alonzo Bernard described identical conditions travelling northward from Fort Snelling to Red Lake Mission in mid-June.

[The roads] were inundated at frequent intervals by floods resulting from the melting snow, farther north and the recent heavy showers...the team becoming mired in the deep mud, an unavoidable delay was caused; and a situation ensued which the rain, now descending in torrents, was not well calculated to relieve. (Schell, Rev. J.P., 1911. In the Ojibway Country. A Story of Early Missions on the Minnesota Frontier. Chas. E. Lee, Publisher, Walhalla, N.D., p. 110)

When the Woods Expedition reached Pembina on August 1, they found the Red River apparently out of its banks.

August 1: ...having been out since the 6th of June, -we arrived at Pembina, and found the Red river and the Pembina river with about twenty feet rise in them, and overflowing their banks. (Woods, op. cit., p. 18)

High water and the possibility of flooding had been a source of concern since mid-June.

June 17: The water of the [Red] river [at Pembina], which is rising rapidly, makes us fearful; a part of the seed put in the low ground is going to be ruined. (Belcourt, G.A. Letter to Reverend C.F.Cazeau, Secretaire de l'Archeveque de Quebec, date Pimbina [sic], Riv. Rouge, Territoire de Minnesota, 17 juin, 1849. Belcourt Papers, Correspondence 1846-1857, p.1,328, Minnesota Historical Society, Minneapolis)

June 26: The water is extraordinarily high...all the rivers are inundated, they say that Pembina is drowned and it is believable from the height of the water here. there is already grain in the water and it doesn't seem to have decided to lower yet...it rains often and without doubt much more copiously upstream than here. (Msg. J.N.Provencher, Bishop of the Northwest, to Msg. I. Bourget, Bishop of Montreal, dated St. Boniface, 26 June, 1949, PAM MG7 D1)

June 27: The convoy has left and the water is extremely high. They say that Pembina is drowned; it is not possible to ride on the prairie and the water rises continually. Much wheat perishes because it rains often...M. Belcourt writes me that the wheat [at Pembina] is almost drowned and the soldiers are stopped by the water he thinks...It is very difficult to communicate except by canoe. (J.N.Provencher, Bishop of the North-West, St. Boniface, Red River, to Monseigneur P.-F. Turgeon, Bishop of Sidyme, Quebec, 27 June, 1849, in Lettres de Monseigneur Joseph-Norbert Provencher, Premier Eveque de Saint-Boniface, Bulletin de la Societe Historique de Saint-Boniface, vol.III, 1913, Imprimerie du Manitoba, Saint-Boniface, Manitoba, p. 271)

The heavy rains appear to have continued through much of August.

August 8: The ground [around the fort] was one swamp with the incessant rains. (James Journal, op. cit.)

August 15: The almost incessant rains and the condition of the country prevented us from responding to this politeness [an invitation to visit Fort Garry from Pembina]. (Woods, op. cit., p. 20)

Unable to travel from Pembina to Fort Garry, Woods set out to explore Pembina Mountain, 50 km to the west.

August 14: ...travelled nearly due west for about 8 miles and found the prairie so horribly bad that I turned back...I had a guide who has lived in this country thirty-four years...[who] said, after seeing the condition of this route, it would be useless to attempt any other. Our horses mired over nearly the whole of the distance. (Woods, op. cit. p. 19)

August 26: I waited [at Pembina] from the 1st to the 26th of August hoping the country would dry sufficiently for me to pass over it, but was disappointed. The improvement of the prairie by a few successive clear days, a hard rain would restore to their previous impassable condition. (Woods, op. cit., p. 19)

At the end of August, Provencher wrote

The water has been so high all summer that there was no way to communicate with Pembina except by water...A company [Woods' Dragoons] visited his [Belcourt's] post and they had to leave because there was no appearance of a harvest at Pembina; the water covered the fields. (Letter from J.N.Provencher to Monseigneur I. Bourget, Bishop of Montreal, dated St. Boniface, June 26, 1849, PAM MG7 D1)

The flood ended in the latter half of August.

August 26: When the expedition first reached Pembina [August 1], the incessant rains for weeks previous had caused all the rivers to overflow their banks; but when I embarked to ascend the Red River [August 26], it had subsided into its usual channel. (Pope, op. cit., p. 34-35)

ANTECEDENT CONDITIONS:

This flood was produced by excessive rainfall after the snowmelt period. The preceding winter seems to have been unremarkable and the breakup, although very late, seems not to have produced unusual water levels in the Red River.

STATE OF ASSINIBOINE:

No information exists about the Assiniboine basin in the summer of 1849.

SUGGESTED MAGNITUDE:

The Red was overbank at Pembina but apparently not in the Red River Settlement. A discharge somewhat smaller than 1948 seems appropriate.

Flooding of the Red River in July or August as far downstream as Pembina or below is a highly unusual occurrence- the modern (1916-1990) discharge record at Emerson indicates that bankfull discharge in these months has a 20th Century exceedance probability of less than 1%.

1850

RED

Spring, Summer

This event had characteristics almost identical to the 1849 summer flood, beginning with a remarkably late spring followed by heavy rainfall and flooding in June and July.

April 30: We have now got to the end of April and the river still solid and snow upon the ground. (Journal of J. Smithhurst [at Indian Settlement], PAM MG7 B2 CMS A97)

April 30: The River began to clear. (Robert James' Journal, PAM MG7 B2 CMS A92)

May 4: This day the ice in the river broke. (Smithhurst Journal, op. cit.)

May 24: The rain poured down in torrents for several hours last night and it has rained more or less all day so that the plains are deluged with water. The river is also excessively high and the current strong. (ibid)

May 25: I took my small boat and four strong men [to the Fort] but such was the force of the current that we did not get the 8 miles till near 1 o'clock [from 8 o'clock]. Had we not turned out of the main river occasionally and gone up creeks and over the overflowed plains and in one instance dragging the Boat over a point of land we should have been much longer. (ibid)

June 15: Great crops last year [1849] there will be none [this year] in consequence of high water. The water got in to my kitchen garden and M.? was obliged to leave his house all Pembina under water. (Letter, Andrew McDermot, Red River to G.M.Cary, London, Ontario, dated June 15, 1850, in Cary Papers, PAM MG2 C3)

July 4: Je voulais aller aussitot apres le careme au lac Rouge, mais une abondance d.eau extraordinaire a forme entre le lac Rouge et Pembina une barriere infranchissable... Mais ce deluge a mis obstacle aux resolutions qu'avoient prises les habitants de Pembina de semer beaucoup, car tous leur champs ont ete submerges et le sont encore. La maison d'ecole, le'eglise et le presbytere sont les seules batisses ou l'eau ne soit pas entre...[at Pembina]. (Letter, G.A.Belcourt to Messire Chs. F. Cazeau, Secret. de l'Archev. de Quebec, dated St. Joseph de la Montagne de Pembina, Territoire de Minnesota, E.U., 4 juillet 1850, Belcourt (Georges Antoine) Papers, Correspondence 1846-1857, Minnesota Historical Society, 1328.

July 17: L'eau a fait du dommage, elle a submerge toutes les terres un peu basses, des champs ensemenses ont ete noyes, d'autres n'ont pas etes semes par la crainte d'une pareil sort; l'eau a monte jusqu'a la fin de mai...Je n'ai rien perdu par l'eau ainsi que les Soeurs. Mr. Belcourt n'a pas ete noye dans sa maison, mais le pays l'a ete, pas un grain a ete seme. (Letter, J.N.Provencher, Ev. du Nord-Ouest, to Monsieur C.F. Cazeau, Secretaire du Diocese de Quebec, dated St. Boniface, 17 juillet 1850, in Belcourt (George Antoine) Papers, Correspondence 1846-1857, p. 1328, Minnesota Historical Society)

August 7: Harvest will be unknown among the Canadian Settlers...their fields being overflowed in the spring. (Letter, Robert James to the Secretary of the Church Missionary Society, London, dated Aug. 7, 1850, at Grand Rapids, Red River, in Robert James Journal, op. cit.)

September 17: From the extraordinary height of the waters of the Red River last spring many of the most fertile fields were overflowing and the inundation having been more extensive in that District of the Settlement occupied by the Hunters than [here] farms have, in many instances, been nearly unproductive. (Letter, John Black [Fort Garry] to Arch. Barclay [London], dated Fort Garry, Red River, 17 Sept. 1850, in HBCA London Correspondence from Winnipeg A11/95 1829-1853 #368)

The waters remained high into September, although they had fallen below flood stage.

Late September: There had been a flood that summer, but the waters had gone before the time we came across the plains. It was late in September we arrived in St. Boniface. (Sister Laurent quoted in Healey, op. cit., p. 110)

A particularly useful account which illustrates the magnitude of the flood was given by Harriet Cowan in an interview many years later. Mrs. Cowan travelled north to the Red River Settlement in June (the precise date isn't given).

In coming from St. Louis in the spring of 1850 James Sinclair brought a number of wagons and heavy horses to be used in crossing the plains from Red River to Oregon. "I remember that on the way from Galesboro," said Mrs. Cowan, in telling of that journey, "we saw at Galena in Illinois a railway track which had just been built-the first I ever saw...As we came northward through Minnesota we found a great deal of the country flooded, and we had to come by a different route from the one we had travelled two years before. At Red Lake River, and again and again in order to cross other rivers and streams, rafts had to be made with branches of trees and the wheels of the Red River carts tied together...At Pembina the water extended two miles out from the hill where Mr. Kittson had built his house. We stayed there four days, and then Mr. Kittson sent us in boats to Fort Garry. The expanse of water over which we voyaged from Pembina was in places eight miles wide. At night we had to tie up the boats to the trees...On account of the flood in 1850 James Sinclair had to give up his plan of taking his family to Oregon that year. The start could not be made early enough." (Harriet Cowan quoted in Healey, W.J., 1923. Women of Red River. The Women's Club, Winnipeg, Manitoba, p. 29-30)

ANTECEDENT CONDITIONS:

Water levels were still very high late in the previous summer (1849) and it is assumed that the antecedent moisture status of the basin at freezeup was extremely high. Winter began in mid-November and seems not to have been remarkable, although few entries have survived from November to April. As was noted at the beginning of the flood description, spring was late.

STATE OF ASSINIBOINE:

No information exists about conditions in the Assiniboine basin in 1850.

SUGGESTED MAGNITUDE:

The great magnitude of this flood is indicated by Harriet Cowan's description of the

expanse of water as being "in places eight miles wide," by Provencher's description of the "impassable barrier" of water between the Red River Settlement and Pembina, and by the reports of flooding of fields in the vicinity of the Settlement. The widening of the flooded area south of the Forks, characteristic of 1950-magnitude floods, is indicated by Provencher's statement and John Black's comment that "inundation (was) more extensive in that District of the Settlement occupied by the Hunters than (in the vicinities of the Forks and downstream)," and by James' opinion that "harvest will be unknown among the Canadian settlers..."

This flood, then, seems to have been at least as great as that of 1950.

Statements in subsequent years confirm the extreme nature of this flood.

> September 12, 1851: ...no farming whatever being done [at Pembina in 1851] on account of the annual floods in the valley of the Red River, for three years past [1849, 1850, 1851]- the waters having risen to the height of thirty-one and thirty-three feet above low-water mark, flooding all the country, and inundating the houses at this place [Pembina] to the depth of two and three feet. Mr. Kittson was obliged to leave the post at this place last spring [1850], and take up his residence for a month upon the surrounding highlands. These floods, should they continue, will prove a serious drawback to the settlement of this valley, the half-breeds being loath to be swept off annually. Mr. Kittson had some six thousand rails swept off from his place last year. (Bond, J. Wesley, 1857. Minnesota and its Resources to which are appended Camp-Fire Sketches. Keen & Lee, Chicago, p. 276)

During the great flood of 1852, Dr. William Cowan used the 1850 flood as a reference point during the rising phase.

> May 5, 1852: River has risen same as night before nearly 2 7/8. boat from Pembina reported very high water higher than in spring 1850... (Diaries of Dr. Willam Cowan, PAM MG2 C15 M154)

1851

RED

Summer

This flood, the third "summer" flood in succession, is more poorly documented by observers in the Red River Settlement than the 1850 event but seems to have been somewhat smaller.

In contrast to the two previous years, spring seems to have arrived early.

March 31: I started [to the Bishop's] but was compelled again to return. The water was covered by a thin ice, not sufficient to bear the horse & he was in danger of cutting his legs at every step. (Robert James Journal, PAM MG7 B2 A92)

April 2: The River broke this evening & again we saw open water. It was feared the spring had come too early to continue, & today the weather became much colder. The ground was again covered with snow after being clear some time. (ibid)

The first mention of high water follows apparently heavy rain in July.

July 15: voila bientot quinze jours qu'il pleut, l'eau monte et montera, la recolte qui est probablement trop belle n'est pas avancee, et sansdoute que cette abondance d'eau va lui nuire beaucoup... (Letter, Bishop Provencher, Bishop of the Northwest, to Msg. I. Bourget, Bishop of Montreal, dated St. Boniface of the Red River, 15 July, 1851, PAM MG7 D1)

July 21: Les pluies abondantes ont fait dommage aux grains. L'eau monte toujours et pourrait detruire la recolte dans les terres peu elevees; deja c'est la cas a la Prairie du Cheval Blanc. (Letter, J.N. Provencher, Eveque du Nord-Ouest, St. Boniface de la Riviere Rouge, to L'Archeveque du Quebec, 21 Juillet, 1851, in Lettres de Monseigneur Joseph-Noerbert Provencher, Premier Eveque de Saint-Boniface, Bulletin de la Societe Historique de Saint-Boniface, vol. III, 1913, Imprimerie du Manitoba, Saint-Boniface, Manitoba, p. 279)

Most of the other evidence for high water and flood is indirect or after-the-fact. Perhaps the strongest indications of a remarkably wet summer come from reports of exceptional floods in the valley of the Minnesota River, southwest of the upper Red River basin.

May 25: Left St. Louis in the steamer Diana Vernon for Tully but on arriving at Hannibal discovered that the water had risen to an unprecedented height having overflowed its banks & spreading over the praries [sic] & bottom lands had in some places swelled to fifteen miles in width where it usually is but one. (Frank B. Mayer in Heilbron, B.L. [ed.], 1932. With Pen and Pencil on the Frontier in 1851: The Diary and Sketches of Frank Blackwell Mayer. The Minnesota Historical Society, Saint Paul, p.76)

July 7: This is an unusually rainy season & we are almost daily visited by storms of wind & rain, the severest came at midnight and broke our dreams by its terrific howl. For two hours the lightning flashed continuously...torrents of rain...The accumulated streams descended from the hills...[on the

lower Minnesota near Traverse de Sioux, date approximate]. (ibid, p. 174,177)

July 14: Our progress being up stream & in opposition to a strong current our arms were fully employed, what with polling, paddling & portaging, wading thro' sloughs & pushing the canoe thro the tangled bushes & grape vines, for we passed thro forests which are usually ten feet above the river bank, we had a fair example of voyaging by the time we arrived at the foot of the opposite bluffs...The river enlarged to ten times its natural size & covering meadows & skirts of timber usually high above its banks, extended to the foot of the hills on the opposite side [on lower Minnesota River]. (ibid, 185-186)

mid-July: The [Minnesota] river was then higher than it has been for years. (ibid, p. 190)

August 30: ...the great floods of the west have reached the valley of the Minnesota River...The valley of the Minnesota has been overflowed three times in succession since last spring. tradition gives no account of such an event. Four bands of the Sioux planted in the valley of the Minnesota river; their corn-fields were all swept away; a fifth lost part of their corn-fields. (Parker, D.D. The Recollections of Philander Prescott, Frontiersman of the Old Northwest 1819-1862. University of Nebraska Press, Lincoln, Nebraska, p. 216)

August 31: The summer of 1851 came, which brought great changes and prepared the way for others. It was one of the very wet summers in Minnesota, when the streams were flooded all the summer through. In making our trip for provisions in the spring, we were detained at the crossing of one stream for almost a week...The Minnesota was very high, spreading its waters over all the low bottom contiguous to the mission premises [Lac qui Parle]. (Riggs, S.R., 1880. Mary and I: Forty Years with the Sioux. Congregational House, Boston, p. 139)

More direct observations about the state of the Red River conditions are given by late-summer visits to Pembina by John Black and J. Wesley Bond.

September 11: Arrived at Pembina...we came to a halt and reconnoitred, standing almost glued fast in the stickly, tenacious mud caused by the rains and overflow of the Red and Pembina Rivers for three years past. (John Black in Bryce, G., 1898. John Black, The Apostle of Red River. William Briggs, Toronto, p. 39)

September 17: After Sunday was past for two days the weather was bad, but on Wednesday, 17th, the day was fine...[They set off]...Everywhere were to be seen traces of the high water which had prevailed for several years, and marks upon the trees thirty feet above the water were seen where in spring the freshets had reached. (ibid, p. 40)

September 12: ...no farming whatever being done [at Pembina], on account of the annual floods in the valley of the Red River, for three years past [1849, 1850, 1851] - the waters having risen to the height of thirty-one and thirty-three feet above low-water mark, flooding all the country, and inundating the houses at this place to the depth of two and three feet. Mr. Kittson was obliged to leave the post at this place last spring, and take up his residence for a month upon the surrounding highlands. These floods, should they continue, will prove a serious drawback to the settlement of this valley, the half-breeds being loath to put in crops when they are liable to be swept off annually. Mr. Kittson had some six thousand rails swept off from his place last year. (Bond, J. Wesley, 1857. Minnesota and Its Resources to which are appended Camp-Fire Sketches. Keen & Lee, Chicago, p. 276)

September 25: [Harvest] usually takes place here [Pembina] about the 20th August, and is a full month later this year than common, the season having been very cold and wet up to the 17th August, up to which time fears were entertained for the loss of the whole crops. The weather fortunately changed, and for a month was very warm and fine. (ibid, p. 325)

ANTECEDENT CONDITIONS:

As in the 1850 flood, it can be assumed that the moisture status of the basin at freezeup in the previous fall (1850) was extremely high. Autumn seems not to have been particularly severe, nor the winter early. The rivers did not freeze over until the third week of November, somewhat later than usual.

> November 18: The ice is drifting down the River in large pieces denoting the intensity of the frost. It will be fast in a few days. (James Journal, op. cit.)

Little information is available for the winter period but again there is no indication of particularly severe conditions. James reported mild weather beginning in early March, with a strong thaw in mid-March and an early beginning to breakup.

> March 16: A lovely day. The roads almost impassable from the rapid thaw. (ibid)
>
> March 19: ...to my surprise I found the Plains with so little snow upon them that after wretched travelling [in the cariole] I did not reach the cottage. (ibid)
>
> March 20: Had intended to see the Bishop today, but was informed of the unsafe state of the River, large openings have appeared in several places. (ibid)
>
> March 24: Mounted my horse to visit the Bishop. I expected the plains would be one pool & found both snow & water deep. I persevered at walking pace beyond Middle Church when a tremendous drift crossing the road interrupted my progress. (ibid)

The subsequent breakup is noted at the beginning of the flood description above.

STATE OF THE ASSINIBOINE:

There are no direct references to the Assiniboine but Provencher implies that the water was high and overbank at White Horse Plain.

> July 21: L'eau monte toujours et pourrait detruire la recolte dans les terres peu elevees; deja c'est la cas a la Prairie du Cheval Blanc. (Provencher, op. cit.)

SUGGESTED MAGNITUDE:

The extent of flooding at Pembina, flooding of low ground in the Red River Settlement and the very high contribution of the Assiniboine suggests a flood greater than 1948 and possibly as large as 1966.

1852

RED, ASSINIBOINE

Spring

The 1852 flood, the second largest and best documented of the historical floods, is especially interesting because its estimated discharge and peak stage were approximated by those of 1997. The very large amount of information about the flood is reported in detail in the Red River Basin Investigation Report:

Canada Department of Resources and Development, 1953. Report into Measures for the Reduction of the Flood Hazard in the Greater Winnipeg Area: Appendix B, History of Floods on the Red River, Red River Basin Investigation, Water Resources Division, 106 p.

The summary below is principally taken from notes prepared by David Anderson, the Bishop of Rupert's Land.

April 23: ...river rose 14 inches last night. Ice still fast and people crossing. (Diaries of Dr. William Cowan, PAM MG2 C15 M154)

April 25-May 1: The ice partially broken up, rendered it unsafe to cross the river. A few however, came over in the morning... Large masses of ice passed during the evening and the following day. The water had risen much, even before the ice gave way, and continued doing so during the week, there being no outlet for it yet towards the lake. The rise was sometimes a foot or a foot and a half, in 24 hours. (Anderson, D., Notes of the Flood at Red River, 1852, by the Bishop of Rupert's Land, 1852. PAM MG7 B2 CMS A83)

April 26: [Ice] on main river started about ½ past 8, and clear water as far as visible up and down. Assiniboine fast... (ibid)

April 27: ...both rivers pretty clear of ice, small river has fallen a little... (ibid)

May 3: [We] were encouraged by the very slight rise during the night, but from 10 AM till 2 PM the waters gained so fast, as to lead to very painful forebodings. Some houses opposite to us were already abandonned, their inmates tenting on the little knolls behind. We hear of one settler taking a bateau right through his house, another with a boat at his door. From the Fort we hear that more than fifty deserted houses may be seen. Since the melting of the snow the weather has been remarkably fine with a strong drying wind. (ibid)

May 4: Rode up to the Fort- the sight very distressing. The bridges are all giving way... (ibid)

May 5: Towards night heavy rain commenced, the first since the breaking up of the ice. (ibid)

May 7: ...In every direction there are processions of cattle, horses, and carts going to the Little Mountain...One stable drifts down the river. (ibid)

May 9: We had heard over night that the waters were stationary at Pembina; but the great rise in the night dispelled such a pleasing idea...The pathway to the Church was open but only just so; the waters had entered one corner of the churchyard, and had the service been three hours longer, we

could not have gone over dry sod...Some came over their cornfields in the large boat...Others were ferried across the creek where my bridge was many feet under water...South wind is bringing down a prodigious amount of water...The Red River opened for itself fresh channels into the Assiniboine above the junction, so that from Pembina to our settlement was a broad lake... (ibid)

May 10: Another beautiful morning, but the rise in the night greater than any previous one. The water was now in the granary and store, and I was some time standing in the water... They were distressed at finding us so surrounded with the waters. Their accounts were most painful. The barn of Emilien, the largest farmer among the Canadians, had floated away; they reported, also, the loss of many other houses... (ibid)

May 11: The rise in the night rather less; the platform was now floating; my garden, the last dry spot, was now under water, and the churchyard...was also covered. (ibid)

May 12: ...The rise in the night had been very great, and the wind was strong from the south-east. This caused a violent current against the house, which we could hardly stem on our return. (ibid)

May 13: After a most tempestuous night, a bright morning; the wind falling but still considerable. The rise much as before... (ibid)

May 15:The cold of the previous day had almost prepared us to expect the snow and sleet which fell this morning and continued for some hours- a most wintry aspect for the middle of May. Nearly thirty had slept under the roof...An evident decrease in the rise of the water... (ibid)

May 15: From 7 A.M. yesterday to the same hour today the rise has been 6 ½ inches - Snowing & blowing from the north, very cold. At 10 P.M. no increase the water has been stationary since morning. (Winnipeg Journal, HBCA B.235/a/15 1851-54)

May 16: From last night till noon today the rise has only been 5/8ths of an inch. (ibid)

May 17: Since yesterday morning till this the rise has been about 10 inches, that being now the depth on the house floor. On the store floor it is 13 inches deep. The Pembina boat returned. Heard from Mr. Setter there that the water has been 6 feet 2 ins. deep around the house but that up to the 14th it had been 1 foot 4 ins. a very favourable symptom for us here. (ibid)

May 19: [At Indian Reserve near Selkirk] All was energy around; we seemed to have passed to another atmosphere. ploughing was going on on both sides of the river...those whose land was dry feeling the necessity of cultivating on a larger scale. (Anderson Journal, op. cit.)

May 19: Since yesterday the water has been stationary. (Winnipeg Journal, op. cit.)

May 21: The river still stationary. The height on the whole is certainly not so great as in the former flood, perhaps by about 18 inches, but as the channel of the river is deeper and broader, and the creeks very much enlarged, there may be an equal volume of water. Delighted to find that the water had sunk an inch in my own house... The river was like that of a vast lake studded with houses, of many of which the projecting gable was the only part visible... (Anderson Journal, op. cit.)

May 22: W S.W. water subsided about 2 inches since yesterday morning...cloudless. (Winnipeg Journal, op. cit.)

May 23: Water fallen two inches since yesterday. (ibid)

May 24: Strange sights met our eyes as we proceeded. Some of the bridges we saw four miles below their former locality, and on the opposite side of the river...A barn had been tied to a strong tree, to secure it, but it eventually floated off. The houses, many of them standing up to their eaves in water... Here [at Parks Creek] the current, from being confined within narrow limits became more

impetuous...The rapidity of the current almost made one giddy to look at it, it was running at the rate of eight or ten miles an hour. (Anderson, op. cit.)

May 24: W NE warm river falling about same rate...water has subsided very much to day. (Cowan Diary, op. cit.)

May 25: The breadth of the whole expanse was supposed to be, in some places, twelve miles... (Anderson, op. cit.)

May 26: Went down to our house in the morning; gratified to find only twenty inches of water, instead of forty, in our rooms. (ibid)

May 26: Water still falling gradually. off the house floor today after being there 11 days. Sounded the channel of the river today; Red River 47 feet and Assiniboine 42. (Winnipeg Journal, op. cit.)

May 28: W SE. light breeze...sky overcast. water still falling about same rate...5 PM raining blowing fresh. N.E. cold. (Cowan Diary, op. cit.)

May 29: The water continues to fall. (Winnipeg Journal, op. cit)

May 31: Water still falling and more rapidly. (ibid)

June 3: ...the land is fast reappearing. The chief fear now is the slip of the bank; many houses are supported and propped up, lest the earth should launch forward and carry them away. (Anderson, op. cit.)

ANTECEDENT CONDITIONS:

Relatively little direct information exists about conditions in the basin during the fall and winter preceding the flood. It can be assumed that the moisture status was extreme after the summer flood and heavy rainfall of the preceding summer. Bond reported warm dry weather at Red River Settlement and Pembina through September and into early October.

Thereafter, there is virtually no commentary until the following entries by Black in late March:

March 27: Up to this date this month has been the most snowy of the whole winter. (Extracts from Mr. Black's Private Journal in Winnipeg Journal, HBCA B.235/a/15 1851-54)

April 1: During the whole of last month the weather has been very stormy with a great deal of snow- and today there is little appearance of spring-indeed less, as regards temperature & the quantity of snow on the ground, than there was a month ago. The snow is now very deep and if we have a sudden thaw there will be a great deal of water on the ground. (ibid)

On April 25th, David Anderson reported

the winter had been unusually fine until the end of February, but through the whole of March a great deal of snow had fallen, which seemed sufficiently to account for the present rise. (Anderson, op. cit.)

Thawing weather came very gradually in the last week of April (Cowan Diaries, op. cit.) and river breakup did not occur until after the water was already rising.

April 15: Weather rather chilly, thaw goes on very gradually freezing at night. Some fears of a flood not without some ground. (Black's Private Journal, op. cit.)

April 22: 6 AM W S.E. Ther. 28° Clear...noon W E Ther 49° Cloudless...Saw 6 geese river rising very fast. Ice unmoved...high water. (Cowan Diaries, op. cit.)

April 23: 6 AM W S.E. Ther 32° Bright...noon W S.E. Ther 44°...10 PM W E Ther . 34°...river rose 14 inches last night. Ice still fast and people crossing. (ibid)

April 24: 6 AM. W E. Ther.34°. no rain but sky dark and threatening. river rose last night about 2 inches ice unmoved...Ice has moved this evening in both rivers...river rising...noon W E. Ther. 51°...10 PM W N.E, Ther. 32°. (ibid)

STATE OF ASSINIBOINE:

The Assiniboine basin apparently experienced severe conditions like those on the Red River. Reverend Abraham Cowley reported overbank conditions and apparently extensive inundation between Portage la Prairie and White Horse Plain.

> May 22: Reached Portage la Prairie; Here the people have been flooded out of their houses & we learn that the RR Settlement is also overflowed. (Journal of Abraham Cowley, PAM MG7 B2 CMS M154)
>
> May 24: Left Portage la Prairie & descended the river till nearly sun set when finding a favourable place we encamped. It has become difficult to land when one wishes the banks being generally overflowed. (ibid)
>
> May 25: Reached White Horse Plain much of it is overflowed learned more particulars of R. River flood it is I fear very extensive and destructive. (ibid)

Prior to artificial dyking in this century, the natural channel capacity along this reach was about 15,000 cfs. However, the Assiniboine at Portage la Prairie flows across a gentle alluvial fan which slopes away from the river both to the north and south. For flooding to cover a significant area to a notable depth, discharge must have been greatly in excess of this. Given the severity of the event in the Red River basin, and the clear indication that the Assiniboine was also high, it is not unreasonable to assume a discharge in the 1974 and 1976 range, i.e. 30,000 - 50,000 cfs.

MAGNITUDE:

The hydrograph of the flood has been reconstructed from various diaries (Canada Department of Resources and Development, 1953, op. cit.) Peak discharge for the combined Red and Assiniboine flow below the Forks was calculated as 165,000 cfs,

1857

RED

Spring

A flood in 1857 is referred to in several comments by local observers but there is little actual description of the event itself. It began with a remarkably late spring which is of interest in itself.

April 28: The journey down [to the Indian Settlement] was still on the frozen river but there being much water on the surface from the melted snow the ride was far from pleasant. Nor do I think that it will be very safe in a few days as already during the short time in which it has been thawing the flowing in of the snow water from the land has cut & carved out innumerable slices rendering it a little treacherous along shore. There was a little open water opposite the school house. (Journal of Abraham Cowley, PAM MG7 B2 CMS A89)

April 30: The thaw has so far prevailed as to enable us to remove a little turf...The season for sowing our seeds will be short indeed the winter being so protracted. Although much snow has been thawed on the land near the houses yet far out they tell me winter still holds its sway and even here people have been hauling hay upon the frozen river with oxen & hay frames just as in the depth of Winter. (ibid)

May 2: Sent John Beads an ox load of hay, the ox hauled it across the river on the ice this morning. Went myself over the ice. (ibid)

May 6: River broken. Land on the bank in good order, that further up the field still wet. (ibid)

May 8: Very winterly weather frost & snow & quite a gale. (ibid)

May 9: ...we had near a foot deep of snow this morning it was drifting and snowing so much since last night and the ice passing us thick since last week I never seen the like of so much ice going down the river, the water very high rising still it is just where the old oven was we will be getting afraid if it rises much higher we were as busy this whole week pulling up our wood out of the water and we are not done yet-We have not begun to plough yet though it is so late of the year... (Letter, Jemima Ross [Colony Gardens] to James Ross [Toronto], PAM RFC 207)

May 9: I left home about 10 o'clock and did not reach there [St. John's] till 4 in the afternoon a distance of 13 miles. I never had such a journey. It had been thawing all the former part of the week which made the roads like a Lake, last night the wind changed to the North which immediately brought frost & snow this continued all day. The surface of the road was just a crust of snow & ice...The wind blew furiously bringing with it snow & sleet or rather particles of ice for it liteally cut my face. (Journal of William Kirkby, PAM MG7 B2 CMS A92)

May 13: ...Did a little in the garden the heat very great the Snow must soon disappear. (ibid)

The first speculation and reports about an actual flood were by Abraham Cowley.

May 12: The season for sowing is so far gone that although the land is very wet we must plough...The water here has risen to such a height that I imagine the country about the Bishop's is nearly under water. Large quantities of drift wood is being daily carried down by the stream indicating the the river has overflown its banks somewhere. (Cowley Journal, op. cit.)

May 14: ...Heard that many of the low farms above are flooded & that the Scotch people have fled from their houses & I am inclined to believe it as the water here is so high. (ibid)

May 15: Water still rising... (ibid)

May 16: The snow has nearly disappeared another warm day will melt it all no doubt & then perhaps the temperature will be more uniform...Owing to the very wet state of the land farming operations have been more difficult this year. (ibid)

Spring: Unfortunately, the high water of this season flooded up the posts [of a bridge installation across Riviere Sale], and undid all the labour of erection. (Minutes of Council of Assiniboia, June 25, 1857, quoted in Oliver, E.H., 1914. The Canadian North-West: Its Early Development and Legislative Records. Publications of the Canadian Archives, No. 9, Government Printing Bureau, Ottawa, p. 424)

The water in the Red seems to have remained high through June and into July.

June 28: Owing to the very melancholy state of the weather & the great difficulty of crossing the river in a storm we had very few at church today. (Cowley Journal, op. cit.)

July 25: In the early part of this evening we examined the banks of the river [near Pembina], and found that they were raised about 42 feet above the surface of the water. The drift timber is lying plentifully upon flats or hollows, at an elevation of 35 feet, which shows the great extent to which this river must be flooded during the spring freshets. Several times the waters have flooded the fort, and a mark on the gate post indicates where the water had reached during the last great flood of the river, and which is at an elevation of 52 feet where the water stood four feet deep in the courtyard of the establishment...Red River itself is at this time flooded about five feet above its usual level, the depth of water now being 14 or 15 feet. (Spry, I.M. (ed.), 1968. The Papers of the Palliser Expedition, 1857-1860. The Champlain Society, Toronto, Ontario, p. 100)

The last mention of the high water is a comment by John Bunn.

August 10: ...high water and a late Spring all but deprived us of a prospect of a crop-and now that our prospects have exceeded our utmost expectations- we are in hourly dread of a visitation from a plague of Locusts which, having completed the destruction of Minnesota, are within 20 Miles of the Settlement... (Letter, John Bunn [Red River] to William Bayley [Westminster], quoted in Bayley, D., 1969. A Londoner in Rupert's Land: Thomas Bunn of the Hudson's Bay Company. Moore & Tillyer, Chichester, England, and Peguis Publishers, Winnipeg, Manitoba, p. 96)

ANTECEDENT CONDITIONS:

Freezeup occurred on November 3 (Cowley Journal, op.cit.). Snow was reported on numerous days through November and December and seems to have accumulated to a substantial depth by late December.

December 24: The snow was exceedingly deep in the open plains, but the day was mild. (Kirkby Journal, op. cit.)

By early March, the snow cover was described as deep enough to cause some apprehension of a flood.

March 9: The winter very cold the snow is very deep; There is an old woman prophesied that there would be another flood...What shall we do if there should be another flood? (Letter, Jemima Ross [Colony Gardens] to James Ross [Toronto], PAM RFC 205)

Thawing conditions arrived soon after this entry and removed much of the snow cover.

March 16: Still as wet as yesterday. The snow is melting down to pools of water & the ground is becoming quite bare & soft...The spring has never been known to set in so early as this before. (Kirkby Journal, op. cit.)

March 23: ...a very difficult job [the men hauling stones] had to get on & off the river on account of the great rise in the water which the thaw has made. (ibid)

March 30: The general thaw seems to have commenced in earnest it has been raining considerably today & very much of the snow is already melted by the warmth of the past week. (Cowley Journal, op. cit.)

By early April, however, cold winter conditions had returned and remained until late in the month, producing the late spring referred to at the beginning of the flood description.

April 4: An exceedingly rough & boisterous day. The snow & drift were so bad that one had the greatest difficulty in standing against it. (Kirby Journal, op. cit.)

April 8: We have had a severe winter-Still frosty Still much snow-River still sound. (Letter, Rev. John Black [The Manse, Red River] to James Ross [Toronto], PAM RFC 210)

April 12: The weather this morning was very winterly wind high with snow & cold... (Cowley Journal, op. cit.)

April 13: A good deal of snow has fallen today. (ibid)

April 24: The great change in the temperature of the atmosphere may perhaps induce many [to go out]. The thaw seems to be very general & the snow is melting away very rapidly. Ducks were flying about the fields today. (ibid)

STATE OF THE ASSINIBOINE:

There is no information relating to conditions in the Assiniboine basin.

SUGGESTED MAGNITUDE:

There is little evidence to indicate the size of this event, other than Cowley's statements on May 12 and 14 that the area near the Bishop's must be nearly under water and that the low farms are flooded and "the Scotch people have fled from their houses."
Apparently, minimum flood stage was reached but no extensive overflow occurred, suggesting a discharge comparable to 1948 or somewhat smaller.

1860

Miller and Frink (1984) list 1860 as a major flood year (Table 4), citing Upham (1895), but this seems unlikely, or at least was of sufficiently small magnitude to have not affected the Red in Manitoba.

The spring of 1860 was relatively early and marked by very low water in the Red River Settlement:

> April 14: The snow is nearly all away, and there is every prospect of the river being free of ice in a few days. The final disruption commenced about a week ago. The water has been rising for a long time past, and navigation may speedily be resumed. The season has been so far advanced as to enable farmers to commence ploughing the new ground...We are informed on the authority of parties lately arrived from Georgetown-at the mouth of the Buffalo river-that there are indications of the main river being unusually low this season. They say that to the south the snow has been almost entirely melted and that many of the creeks which supply the river are already dry; notwithstanding which the water is below the average depth. Their statement as to the absence of snow is confirmed by the fact that as early as last month they were able to travel from Georgetown to within a short distance of Pembina by means of oxen and carts. But we hope they may be mistaken in regard to the shallowness of the water. (The Nor'Wester Newspaper)

> April 18, 1860: River opens by dissolving the ice, the water being very low there has been too little strength of current to remove it a very unusual case. (Journal of Abraham Cowley, PAM MG7 B2 CMS A87)

> April 28: The ice has disappeared before the advancing heat of summer. The far-famed Red River of the North glides sluggishly at our feet...Distance does indeed lend enchantment to the view of high muddy banks and low muddy water. For the last fifteen or twenty years, the river has not been lower at this season than it is at present. The quiet flow of ice contrasted strongly with the customary rush, crash and splash of former years. How the steamboat is to discharge her important duties this year we cannot imagine. (Nor'Wester, op.cit.)

> May 14: [American travellers] repeat the universal story regarding the shallowness of the water, of which three or four detentions on sand-bars afforded them practical illustration...Of late, the weather has not been so pleasant as the fitness of the opening spring had led us to expect. For the season, the winds have been cold, and since we last wrote on this topic, we have been visited by two or three smart snow storms. Agricultural operations, however, do not seem to have been greatly retarded. Nearly all the cereal crops are in the ground, and if the seed has not been nourished by sunshine and rain, neither has it been injured by cold. (ibid)

Rain fell on several days in the latter half of May and June was a very wet month, causing the river to rise.

> June 14: On all hands it is admitted that a season more favourable than the present for the growth of the wheat crop has never been known in Red River. Showers are plentiful and sunshine abundant...The river continues to rise rapidly though for the season it is unusually low. (ibid)

> June 17: Owing to the very wet weather [the attendance at church was small]. A very great quantity of water has fallen, the valley in our field was so filled with water that it produced quite a rapid current. (Journal of Abraham Cowley, PAM MG7 B2 CMS A87)

> June 28: The present has been a very rainy month. We have had showers throughout at short

intervals. The first week rain was very much required, and was welcome, even in the second; but farmers think that during the last fortnight we could have dispensed with it advantageously for sunshine and clear sky...The water has risen steadily during the present month, and is now higher than at any time previous this year...If the rain continues, there will be abundance of water for the Anson Northrup...At present she has enough and to spare...[The passage of the Canadian mail] through the Lake of the Woods detained them three days, owing to a heavy gale of wind which prevailed, and against which they could not make head in their boats. They found much of the subsequent portion of their route almost impassable-the streams being all swollen into little rivers by the late rains, and the morasses so flooded with water that their men frequently sunk therein up to their breasts... (Nor'Wester, op. cit.)

Rain continued to be reported through July and into August.

July 14: In our last, we stated that the month of June was more than unusually rainy. By the close of the month there was more rain than was necessary for healthy vegetation. The first half of July, we regret to say, has been a continuance in an aggravated form of the same wet season...If we have as frequent rains for the next fortnight, very serious damage will be done to our farming interests... (ibid)

July 28: Mr. McVicar [carrying mail from Fort William and Fort Francis] found the rivers greatly swollen by the heavy rains, and he and his party were compelled to swim several of them with the mail bags on their backs...Per contra the river is falling all the way from Georgetown to Fort Garry. (ibid)

August 28: On the whole, the weather has been favourable during the last ten days. Contrasted with the previous storms of rain, we might almost say it has been quite dry...On arriving at Georgetown with the boat last trip we found the water so low (averaging a little over two feet from Sand Hill river to that point and still falling, that we concluded...to load the barge and run down with it, hoping that on our return there might be a rise in the river. (ibid)

August 31: I hear many people say that they never remember such a summer for rain, it is indeed been wonderful all through...22nd Still verry rainy weather...24th some rain every day... (Diaries of Samuel Taylor at Red River Settlement, PAM MG2 C13)

Upham (1895) gave no basis for listing 1860 as a flood year. Although the summer appears to have been sufficiently rainy to produce high water levels in smaller tributaries, and cause the Red to rise from low spring levels throughout much of the June and early July period, there is no indication that the Red River was near overbank stage.

1861

RED

Spring

This is acknowledged to be the third largest historical flood, although it is less well-documented than the 1826 and 1852 events.

> April 15: ...this last winter has been more than average in length and in quantity of snow, but not in severity...The roads are in a dreadful state at present and very few people are to be seen moving about. The abundant snow has resulted in lakes and swamps the whole country over. Vegetation is just beginning to sprout, ducks and geese are being welcomed on all hands; creeks are pouring their volumes into the river, and the signs of the times generally make us feel that spring is upon us. (Nor'Wester Newspaper)

There must have been some apprehension of a serious potential for flooding because the April 15 Nor'Wester also contained a description of the 1826 flood.

> April 30: 1st rather a rainy day...5th plenty of water on the ground...6th plenty of water...and raining a little mostly all day we have not seen the sun this two or 3 days back...7th verry soft and snowing thick, some geese seen up at the Rapids...[9th] found the water so deep that we had to just come back [from cutting fencing]...it began to snow thick soon after dinner on the 13th...the 14th was a fine clear day wind N.N.W. all day...the River began to break up in the evening of...the 15th but soon stopped over the night...19th a pretty day...20th a fine day...21st a fine warm day wind south...25th--the water is high now and plenty of wood going down every day, and many people left their houses now owing to the high-water. Water is still rising this 30th...a verry wet rainy spring the like has not been seen this many years back. (Diaries of Samuel Taylor at Red River Settlement, PAM MG2 C13)

> May 1: The general flood which is overspreading the country will necessitate a temporary suspension in the publication of The Nor'Wester. If the waters continue to rise any longer, we shall be compelled to migrate with the multitude to distant ridges and enjoy the red man's life for some weeks. Should they recede we shall continue uninterruptedly, but there may be difficulty in the delivery as nearly all the bridges are swept away. (Nor'Wester, op. cit.)

The Report on Investigations Into Measures for the Reduction of the Flood Hazard in the Greater Winnipeg Area contained the following extract from the Nor'Wester:

> As we write, the waters of the Red River have almost rolled in at our doors; and there is every indication that we are on the eve of a great flood...The unusally large quantity of snow which fell during the winter has entirely disappeared within the past fortnight. The creeks have all swollen to the size of rivers; and the main river has received from this source and from its numerous larger tributaries such copious supplies that since ever the ice commenced to break up, the channel has been constantly widening and deepening until the waters have all but overlapped even the highest portion of the banks....As early as a fortnight ago, the main river broke bounds at many points in this Settlement and elsewhere. At Georgetown, it completely inundated the inhabitants--greatly deranging the plans and workshops of the enterprising owners of the Anson Northrup, and floating the pioneer craft herself a long distance into the woods, where she got entangled with some twenty feet of water under her. In the Company's warehouse, there were, on the 14st inst., three feet of water; but,

fortunately, the goods were all saved from damage. The water was not rising so quickly at this date; but, according to accounts forwarded to Governor Mactavish by Mr. A.H.Murray, no dry land was visible from that place, except a small ridge, on which the Company's cattle were feeding. From Breckinridge to Georgetown, the whole country was reported to be submerged; and between the latter place and this settlement, the land was fast disappearing. The water in the Company's store at Pembina was two feet deep on the 23rd ult. Ten miles this side Pembina, Mr. Hugh Cameron...had been driven from home by the waters; and at last accounts, the house itself had floated off.

Throughout a very great section of our own infant colony, the overflowing of the river has caused much confusion and distress. Stealthily and steadily, day after day, the waters rose...Six and sometimes rwelve inches of rise between sundown and sunrise, brought matters to a crisis with very many before long. The river was at their doors--in their dwellings. Then they fled from house to house--still hoping the waters would abate. Fourteen days passed in this way, with no change save the increasing imminency of a general flood which might, probably be greater and more ruinous than any of its predecessors. The creek bridges were all swept away, so that travelling on horseback, or on foot, became difficult and dangerous...Bye and bye, numbers of the good peoples themselves were in full march for the same destination [Stony Mountain]...

Thus far the change to the natural features of the landscape adjoining the river is a very marked one. Familiar headlands have wholly disappeared, and before us rolls a river broad, and wide, and deep, as the Mississippi at Galena...

On the "American side" of the river, Kittson, Cavalier, Marion and the other settlers were flooded out by the 23rd ult. The main river--which had a week before invaded the habitations and stores of August Schubert, A.R.Gerrald-- all in fact who had perched themselves upon the Point--had at this climbed above the eaves of Thibeault's house, and left nothing of the barn discernible except the ridge pole...On the east bank of the Red River, all the buildings in the neighbourhood of St. Boniface, at least, are surrounded by water...The Riviere la Seine, or German River, along which some of them were settled, has now formed a junction with the main river, making the latter in some parts more than half a mile wide...Many fields...are now covered with six to eight feet of water and the tops of some portions of the fencing are barely to be seen...(Nor'Wester, op. cit., May 1)

On June 1, the Nor'Wester added the following information, including an intriguing commentary on the changing channel capacity of the Red.

In our last, we mentioned that a general flood was imminent. We can now say that it has come and gone. It fell far short of former floods in quantity of water and consequent destructiveness, but was still sufficient to cause much loss of property and much suffering. The upper part of the Settlement extending from around Fort Garry, along the Red River to Pointe Coupe suffered the most. That district being generally of a lower level than the parts below Fort Garry (if we except Point Douglas) was therefore under a greater depth of water...

On the point of land opposite Fort Garry...there has been considerable loss. Schubert's establishment is gone, Jerrold's is gone; and a great deal of moveable property belonging to Mulligan, Harkness, McDougal and others...

Point Douglas has been all but rendered worthless. Bouvette lost two buildings, and two of the three left are upset. The two additions to Gaudrie's dwelling were torn off: the main building is much shattered...When we add that all the fencing is away, and that the best of the soil has been washed off by a terrible cross-current it will be admitted that Point Douglas is hopelessly thrown back. The current which sweeps across its base is so irresistable that we verily believe if a drain had been dug from Neil MacDonald's to Klynes just before the flood, the historic Point Douglas would now be an island. The eastern corner of Fort Garry was in water. The Convent and College of St. Boniface were in water a foot deep. The flooding extended downwards to about St. Paul's Church, and showed how remarkably level was the intervening district up to Fort Garry. There was not at most a foot or

two difference betwen any two points...

There was a steady rise of water until ...the 8th of May, when the first pause was observed...the very next day, a fall of one-inch marked its ebb. In a week, it once more slipped into the customary channel, and stray parties could then be seen every day wending their way back from distant ridges...

We do not think that the country below Fort Garry will ever be flooded again, for experience shows clearly that each successive flood has indicated far less depth on the plains than its predecessors--a fact fully acounted for by the rapid widening of the river channel. There may be the same volume of water in each flood, or very nearly so, and the ever-increasing width of the river will explain the disparity of depth on the main land. (Nor'Wester, June 1, op. cit.)

The combination of the flood and rain in June left large amounts of surface water standing on the prairie long after the flood itself was over.

July 1: We have had very rainy weather during the past three weeks...We have had but very little warm weather, so far. The spring has been a long, raw, and disagreeable one. Very few will be able to commence haymaking at the usual date, July 20, on account of the immense lakes still covering the back pastures. (ibid)

ANTECEDENT CONDITIONS:

The previous summer had been very wet, causing the Red River to rise in June and July. Rainy weather continued into the early fall and it is likely that the basin was well-saturated at the onset of freezing temperatures which began early in November.

November 15: Indian summer is gone. Not the slightest trace or resemblance remaining of that lovely season. It lasted eighteen days. October closed delightfully and right auspicious was the first of November; but, how different the second! Dark, cloudy, and cold, with pelting rain all day, followed by snow which fell unremittingly for 24 hours! The wind was north and piercing enough for December or January. The cold weather which thus set in, as it were, in a day has continued ever since. The ice set fast, partially on the morning of Guy Fawkes' day. The ground is entirely covered with snow... (ibid)

Milder temperatures in November removed this snowfall and delayed complete freezeup of the river until November 19. Accumulation of significant snowpack did not begin until a heavy snowfall on November 28.

Cold and mild conditions alternated for the remainder of the winter and snow was frequent, particularly in March. According to Samuel Taylor and The Nor'Wester Newspaper, the snowpack was deep by the beginning of the melt season.

March: ...6th a fine day...snowing thick upon the 12th there is now a great quantity of snow upon the ground...16th a cold windy day clear...17th was a cold day south wind...18th snowing thick and south wind, snowing thick on the 19th...22nd cold windy weather...24th snowing it is as winter like yet as it was any time in winter, and the snow is very deep...31st...a fine day soft walking...30th was the beginning of the first soft weather. (Taylor Diaries, op. cit.)

April 15: ... this last winter has been more than average in length and in quantity of snow, but not in severity...The abundant snow has resulted in lakes and swamps the whole country over."

(Nor'Wester, April 15. op. cit.)

Despite the Nor'Wester's comment about the length of winter, however, spring was not late. Thawing conditions began at the end of March and the snowmelt water was augmented by much precipitation in April, as the water was beginning to rise.

> April: 1st rather a rainy day...5th plenty of water on the ground...6th plenty of water...and raining a little mostly all day we have not seen the sun this two or 3 days back...7th very soft and snowing thick...it began to snow thick soon after dinner on the 13th...Water still rising this 30th...a very wet rainy spring the like has not been seen this many years back. (Taylor Diaries, op. cit.)

A further indication that rain prior to and during the flood was a significant factor is the comment by Governor Mactavish after the peak:

> May 16: ...Many...have lost heavily and will yet suffer more as it will be late in the season before they can sow their lands, up to this time in this respect those whose lands were flooded are not much behind those whose lands were above water as the spring has been so wet and inclement that there has been very little farming done. (Letter, W. Mactavish, Acting Governor of Rupert's Land, to Thomas Fraser, Secretary of Hudson's Bay Company, dated at Fort Garry, May 16, 1861, HBCA A.11/96, fo. 569d)

STATE OF THE ASSINIBOINE:

On April 17, the Fort Pelly Journal noted that "the water in the river [was] very high" (HBCA, Fort Pelly Journal Sect. B, 1861-62 mfm 475). This is the only mention of the state of the river among daily entries through the entire flood period and beyond. It is concluded that the Assiniboine was probably within its banks during the 1861 flood on the Red.

SUGGESTED MAGNITUDE:

Peak discharge was estimated by the Red River Basin Investigation to have been 125,000 cfs.

1867

A single reference, by Walter Traill at Fort Qu'Appelle, quoted in his memoirs, suggests that there was a significant flood in the summer of 1867.

> A week of August remains [at Fort Qu'Appelle] and surely it is very early to have cold weather. The summer season is very short. On the twenty-ninth of May, our boats all stopped at Fairfield because of ice. We have had little warm weather in June, with snow on the thirteenth on my boat trip to Fort Ellice. We have had a miserable wet summer with rain that has done a great deal of damage to crops in Red River Settlement where a large part of the French Settlement has been completely flooded, and many of their houses carried away. (Walter Traill, in Atwood, M., 1970. In Rupert's Land: Memoirs of Walter Traill. McLelland & Stewart, Toronto, p. 86)

It is difficult to understand this comment since there is no indication from those at the Settlement that water levels were abnormal from breakup onward. It is concluded that Traill must have been misinformed.

1869

RED

There is some slight evidence of minor flooding in the spring and summer in the upper Red River basin.

> April 17: We are informed that the Red River has overflowed its banks at Fort Abercrombie and that things up there are afloat generally. Very shortly after the river is clear of ice we may look for the flat-boats...The snow had disappeared from our plains on the 17 inst., and the rivers are rapidly breaking up. (Nor'Wester Newspaper, April 17)

By the end of April, however, concerns were being expressed about the possibility of low water.

> April 26: the steamboat came up and got nearly all hands to work to get her lading on board so that the delay should be as little as possible as the river seems to be falling rapidly. (Hudson's Bay Company Journal, 26 April, 1869, quoted in Ingram, G., Industrial and Agricultural Activities at Lower Fort Garry, Canadian Historic Sites, Occasional Papers in Archeology and History, No. 4, p. 68)

The river isn't mentioned again until mid-August:

> August 17: ...river said to have risen. (Diaries of Dr. William Cowan, PAM MG2 C15 M154)

In mid-September, the Nor'Wester newspaper reported

> September 13: A late and pleasant autumn is anticipated to make up for our unusually cool summer...There has been heavy rains somewhere up the country. The Red River has risen during the inst. week some two feet, and we learn that almost all the bridges which crossed the small streams between this and Georgetown have been carried away. (Nor'Wester, Sept, 13, 1969)

Neither of these events had any impact in Manitoba and it is concluded that if flooding occurred, it was minor and restricted to the southernmost sections of the river.

PART C

ANNUAL RUNOFF CONDITIONS 1793-1870

INTRODUCTION

In this section, an attempt is made to characterize runoff conditions in the Red River basin on a water-year basis (October-September), based on the archival descriptions of water levels, weather, river breakup dates, crop conditions, etc. For each water-year from 1793-4 to 1869-70 where sufficient information exists, runoff is classified as Very High, High, Normal, Low, or Very Low, using 20th Century conditions as the basis for comparison. The classification is conservative- for example, only years in which overbank flow occurred are classified as Very High, although some other years with a strong (but non-flood) freshet and a very wet summer might in fact have produced much the same runoff volume. The most difficult category to identify is Normal since it usually produced the least commentary. In general, years in which adequate records exist but which make little reference to the state of the rivers, and in which other conditions such as winter snowfall, spring and summer rainfall, etc. appear unremarkable, are classified as Normal. In 10 of the 77 years covered by the survey, data were insufficient or non-existent and these years are not classified. Because the emphasis is on the Red River, years in which information is exclusively about the Assiniboine basin have not been classified.

The classification attempts to consider the overall runoff which might have been produced within the water-year. Consequently, it does not necessarily imply that conditions met that description in all seasons. In some years, high spring runoff was considered to have compensated for apparently low summer flow or even drought-like conditions; in other years, a below-average freshet was compensated for by a very wet summer with clearly above-average flow conditions. Each of these cases might have been classified as normal, despite a striking imbalance between the seasons.

Because the classification is subjective, extensive citations of the archival record are given to indicate the basis for the judgement. Commentary by the author of the report is given in note form only. The details for flood years which have been summarized in PART B are not repeated but reference is made to the relevant points. The citations are a much -abridged version of the entire data base. In some years, virtually all relevant material is given. In others, only the most important have been selected. Many of the citations are included not because they alone are the evidence for the point being made but to illustrate the nature of the comments by the observers and to provide a measure of continuity. The focus is on runoff and consequently other significant environmental observations (grasshoppers, grass fires, etc.) are omitted unless they appear to be directly relevant to the runoff process.

1793-94 **- INCONCLUSIVE**

- numerous references to very shallow water on Assiniboine in fall
- numerous drowned buffalo on Assiniboine above Brandon, April 30 and May 1
- very high water reported on Winnipeg River

1794-95 **- INCONCLUSIVE**

- low water on Assiniboine in fall, 1794

  November 11, 1794: [Assiniboine] River very shoal and Ice in it every Day. (Letter, J. Linlater, Burnt Carrying Place near Pine Fort to Robert Goodwin, Brandon House, dated Nov. 10, 1794, Brandon House Journal B.22/a/2 1794-95)

- high water on Assiniboine in spring, 1795

  April 11, 1795: ...the water rises high in the [Assiniboine] River, the small Creek opposite the House open. (Brandon House Journal, op. cit.)

  April 19, 1795: ...the water on the [Assiniboine] River rises very high. (ibid)

- considerable rain reported in May-June and high water on Assiniboine in June

  June 13, 1795: ...with rain the water rises high in the [Assiniboine] River. (ibid)

- probable normal to high runoff on Assiniboine but no information regarding Red River

1795-96 **- LOW**

- shallow water on Assiniboine in fall, 1795

  October 14: Leading in many places the Day-the [Assiniboine] river being Shold and narrow. (Fort Pelly Journal, HBCA B.159/a/2 1795-96)

- shallow water on Assiniboine in spring, 1796

  May 5, 1796: ...water very shoal [in Assiniboine between Brandon and Forks]. (Brandon House Journal, HBCA B.22/a/3 1796/97)

- very low level of Lake Winnipeg and of Assiniboine, August -September, 1796

  August 27, 1796: heavy wind and rain in the morning afterwards fine weather...This Lake however cannot admit of large craft being very shoal, our Boats tuching ground for miles from the [Red] Rivers mouth. (ibid)

  August 30, 1796: ...found the water low in the [Assiniboine at Forks], (ibid)

  September 8, 1796: leading almost all day, hard work, water low making the Journey very disagreeable. (ibid)

- no direct reference to Red but the low state of Assiniboine during entire year and the low level of Lake Winnipeg suggest low runoff on Red

1796-97 **- INCONCLUSIVE**

- low water on Assiniboine in fall, 1796

October 20, 1797: the Batteaux was Stopt by Ice and the Shallowness of the Water in the [Assiniboine] river... (Fort Pelly Journal, HBCA B.159/a/3 1796-97)

November 14, 1797: ...we have not got within five days journey with the Batteaux that we did Last year owing to the Lateness of the season, and the shallowness of the water in the [Assiniboine] river... (Letter, John Sutherland, Fort Pelly, to James Sutherland, Brandon House, Nov. 14, 1796, ibid)

- very high water and flooding in upper Assiniboine in spring, 1797 (PART B)

- shallow water on Assiniboine in September, 1797

September 6, 1797: ...we make very slow way on account of the shoalness of the water [in Assiniboine near Forks]. (Brandon House Journal HBCA B.22/a/5 1797/98)

- no information about Red

1797-98 **- VERY HIGH**

- shallow water on Assiniboine in fall, 1797

October 23, 1797: the [Assiniboine] River set fast here, it being very shallow and no Current, is the cause she sets so soon fast here... (Fort Pelly Journal, HBCA B.159/a/4 1797-98)

- very high water and flooding on Red at Pembina in spring, 1798 (PART B)

1798-99 **- INCONCLUSIVE**

- shallow water in Assiniboine in fall, 1798

October 1, 1798: The fall is coming very soon on, and the water very shoal indeed. I am afraid that we will have a bad journey. (Letter, Thos. Harvey to Robert Goodwin at Brandon House in Brandon House Journal, HBCA B.22/a/6 1798/99)

- no information on spring water levels, 1799

- low water on Assiniboine in September, 1799

September 14, 1799: the waters are very shallow in the [Assiniboine] River this year. (Fort Pelly Journal, HBCA B.159/a/5 1799-1800)

1799-1800 **- VERY LOW**

- shallow water on Assiniboine in fall, 1799

October 16, 1799: they cannot Proceed any further [up] the [Assiniboine] River being shallow and a deal of ice driveing in the River... (Fort Pelly Journal, HBCA B.159/a/5 1799-1800)

- mild winter with relatively little snow in late winter

February 24, 1800: ...very bad hauling broke all their sleds no Snow being on the Paths & very little on the Plains. (Brandon House Journal, HBCA B.22/a/7 1799/00)

February 28, 1800: this has been the mildest Winter here that evere was known it is Pleasanter weather here now than in Summer. (Fort Pelly Journal, op. cit.)

March, 1800: Early in March the snow was entirely gone [at Pembina]. (Alexander Henry in Coues, I. (ed.), 1965. The Manuscript Journals of Alexander Henry and of David Thompson. Ross and Haines Inc., Minneapolis, Minnesota, p. 4)

March 31, 1800: This winter, 1799-1800, we considered one of the most extraordinary known for many years. Early in November we had an extremely heavy fall of snow; but the rest of the season was open and mild [at Whitemud]. (ibid)

- low water in Assiniboine in spring, 1800

April 10, 1800: in the evening the Men returned from the boats-who tells me that they cannot get them further up than my old Station at the Elbow-for want of water. (Fort Pelly Journal, op. cit.)

April 15, 1800: ...the Water in the [Assiniboine] River is very shoal. (Brandon House Journal, HBCA B.22/a/7 1799/00)

- very low water in Red and reference to extreme drought in August

August 22, 1800: I am told the water [in the Red] is lower than has ever been known before... (Alexander Henry, op. cit.)

August 28, 1800: The drought has been so great this season that there is scarcely any water in this little river [Plum River] and the entrance is dry ground; this is thought extraordinary by those acquainted with the country. (ibid, p. 69)

- reference to extreme low water on Clearwater River, indicating its regional extent

October 28, 1800: This river [Clearwater River] is navigeable for small Indian canoes, but very rapid near the entrance, where there is famous sturgeon-fishing in the spring-indeed, it may be said to last all summer, unless the water is very low which was the case at present...But it must be observed this is a year of extraordinarily low water... (Alexander Henry, op. cit., p. 128)

1800-01 **- HIGH**

- flooding on Assiniboine in spring, 1801 (PART B)
- little direct reference to Red but drowned buffalo observed and reference in 1802 to high water on Red in previous year (PART B)
- high water on Winnipeg River, August, 1801

August 25, 1801: I slept in the Pinawa, water being too high to go by the White River [John McKay on Winnipeg River going from Osnaburgh House to Brandon]. (Brandon House Journal, HBCA B.22/a/9 1801-02)

- good flow of Assiniboine in September, 1801

September 9, 1801: ...water very good in the [Assiniboine] river. (ibid)

1801-02 **- NORMAL**

- cold winter and deep snow

February 28, 1802: The cold is very severe, snow deep and no grass. (Alexander Henry in Coues, I. (ed.), 1965. The Manuscript Journals of Alexander Henry and of David Thompson. Ross and Haines Inc., Minneapolis, Minnesota, p. 194)

- high water in spring

May 11, 1802: Nine inches of snow. Water falling it had risen almost as high as last year. (ibid, p. 197)

- no further information; although there is some indication that runoff may have been above-average or high, it seems to have at least been normal

1802-03 **- HIGH**

- early winter

November 4, 1802: We crossed the Red river [at Pembina] on the ice, as it was an extraordinarily early winter; however, it did not last long. On the 6th the river was again clear of ice, and fine mild weather ensued until the 17th, when it began to snow, and we once more ran sleighs. (Alexander Henry in Coues, I. (ed.), 1965. Manuscript Journals of Alexander Henry and of David Thompson. Ross and Haines Inc., Minneapolis, Minnesota, p. 206)

November 24: We had a heavy fall of snow and hail with tremendous claps of thunder and lightning, which continued most of the day, and a strong N.E. wind. About 18 inches of snow fell in 12 hours. The river froze again. (ibid, p. 206)

- deep snow in early January, 1803

January 4, 1803: The snow is very deep, but in the plains hard enough to bear a man on snowshoes and my dogs also. (ibid, p. 208)

February 27, 1803: ...the ground was frozen solid for 3 ½ feet. (ibid, p. 209)

- early spring and high water on Red

March 25, 1803: Heavy rain; snow all gone...Red river clear of ice. Water very high. (ibid, p. 210)

March 27, 1803: The plains are covered with water from the melting of the snow so suddenly...The water is commonly knee deep, in some places up to the middle and in the morning is usually covered with ice... (ibid, p. 210)

- very wet prairie and high water persisted through May

May 24, 1803: Set off...for Portage la Prairie...We found much water in the plains...mosquitoes by the millions. (ibid, p. 212)

May 30, 1803: ...arrived at the Lake [Winnipeg]. Wind a head blowing a Storm. it's amazing the quantity of dead Buffalo we saw coming down the River. I counted 640 in a piece of a day [John McKay travelling from Brandon House to Osnaburgh House]. (Brandon House Journal, HBCA, B.22/a/10 1802-03)

May 31: ...there was too much water on the plains for our horses to proceed [between Riviere aux Gratias (Morris River) and Pembina River]. (Alexander Henry, op. cit., p. 213)

1803-04 **- VERY LOW**

- little snowfall in winter, 1803-04

December 1, 1803: its surprising no snow will fall which prevents the Cattle from coming nigh this place. (Brandon House Journal, HBCA B.22/a/11 1803-04)

December 30: There was not enough snow for a train. (Alexander Henry in Coues, I. (ed.), 1965. The Manuscript Journals of Alexander Henry and of David Thompson. Ross and Haines inc., Minneapolis, p. 233)

February 6, 1804: The grass has been burned here the same as all over the plains of Red River; what little snow falls is instantly drifted off, and the bare ground is so much exposed to the frosts that the earth has cracked in a surprising manner. We met with crevices in the portage half a foot wide, and some few near a foot...The ground is so dry that our dogs and cariole raised a thick dust. (ibid, p. 238)

- nevertheless, Henry reported

March 19, 1804: I set off at dusk for Riviere aux Marais- a tedious trip; no frost but water on the plains, and dogs of no use. (ibid, p. 239)

March 21, 1804: Snow entirely melted. (ibid, p. 239)

- little direct reference to rivers but low water reported in Assiniboine in fall, 1804

October 4, 1804: ...men started for the Elbow, I kept twelve parcels back, as the water here is too shoal. (Brandon House Journal, op.cit.)

- evidence for a intense drought from Lake Superior to Missouri River region from winter,1803-4, to fall,1805, summarized in

Kemp, D.D., 1982. The drought of 1804-1805 in central North America. Weather, v. 37 (2), 34-41.

1804-05 **- VERY LOW**

- low water level in Assiniboine in October, 1804 (see 1803-04 above)
- low water level on Assiniboine in June, 1805 and report of no rain since fall

  June 1, 1805: The [Assiniboine] River [near Pine Fort] at present being so low (as we have not had a drop of Rain since last autumn). (D.W.Harmon in Lamb, W.K. (ed.), 1957. Sixteen Years in the Indian Country: The Journal of Daniel Williams Harmon, 1800-1816. The MacMillan Company of Canada, Toronto, p. 90)

- low water level on Assiniboine, September 25, 1805

  September 25, 1805: The [Assiniboine] water is so shoal and the boats so worn out by hard Launching that the men really thinks that they will not arrive at this House. (Brandon House Journal, HBCA B.22/a/13 1805-06)

- evidence for widespread drought from winter,1803-04, to fall,1805, in Kemp (1982)- see 1803-04 entry

1805-06 **- HIGH**

- low water in fall, 1805 (see 1804-05 above)
- heavy late winter snow and wet spring, 1806 (PART B)
- very high water level (possible flooding) in Red in June-August, 1806 (PART B)

1806-07 **- NO DATA**

- presumed high moisture state in fall, 1806, after very wet summer
- no information on water levels during entire 1806-07 water year

1807-08 **- LOW**

- normal freezeup in fall, 1807
- early disappearance of snow and river breakup in spring, 1808

  April 8, 1808: Snow entirely gone. (Alexander Henry in Coues, I. (ed.), 1965. The Manuscript Journals of Alexander Henry and of David Thompson. Ross and Haines Inc., Minneapolis, Minnesota, p. 429)

  April 9, 1808: The river broke up. (ibid, p. 429)

  April 11, 1808: River clear of ice. (ibid, p. 429)

- low water in Minnesota in May

  May 14, 1808: Jean Baptiste...whome I sent to Leech Lake for sugar, arrived on foot with one Indian, having found the water so low that he was obliged to put his cargoes en cache above Riviere a l'Eau Claire. (ibid, p. 429)

- excessive heat in late June

June 25, 1808: Took horse at Riviere Sale, and set out for my fort. The weather was excessively hot and horse suffered intolerably from the burning rays of the sun. (ibid, p. 430)

- low water in Red in September, 1808

September 1, 1808: the water [in the Red] very low [between Forks and Pembina]. (Journal of Occurrences at Pabana River, HBCA B.160/a/1 1808/1809)

September 2, 1808: the water Shoaler and Shoaler [between Forks and Pembina]. (ibid)

- although the information is not abundant, it seems to indicate low runoff

1808-09 **- INCONCLUSIVE**

- lack of snow in April, 1809

April 10, 1809: [Thomas Thorn] not...able to get the least thing hauled for want of snow. (Brandon House Journal, HBCA B.22/a/16 1808-09)

- grasshopper plague in September, 1809

September 14, 1809: Arrived at the [Brandon] House and found...that the Grass Hopper had eaten all the Vegetables in my Garden...the Men informs me that when they rose they were in such Clouds that they darkened the Sky, they carry their devestation as far as the Summer Berry River. (ibid)

- no mention of river conditions

1809-1810 **- INCONCLUSIVE**

- high water in Assiniboine in spring, 1810 (PART B)
- no information about Red

1810-11 **- VERY HIGH**

- very heavy winter snowfall (PART B)
- exceptional flood on Red in spring, 1811 (PART B)
- normal flow on Assiniboine in spring, 1811 (PART B)

1811-12 **- HIGH**

- relatively high storage in fall after large flood in spring, 1811, can be assumed although there is no information about the nature of summer precipitation

- relatively early freezeup in fall, 1811

October 18, 1811: The weather still very cold a good deal of Ice driving in the [Assiniboine] River. (Brandon House Journal, HBCA B.22/a/18a 1811/12)

October 22, 1811: The ice in [Assiniboine] River set fast strong enough to cross with Horses. (ibid)

- subsequent milder conditions and the Red did not freeze until mid-November

October 31, 1811: I arrived at the forks, found a good deal of Ice still driving in the [Red] River notwithstanding the fine weather of these past few days. (ibid)

- several heavy falls of snow recorded in Brandon House Journal in November
- late breakup, cold spring

April 18, 1812: Weather remarkably cold for this season of the year. (ibid)

April 22, 1812: heavy rain- a good number of Geese & Swans flying northward-so that I hope the Spring is at last going to commence. (ibid)

April 28, 1812: The [Assiniboine] River Ice gave way. (ibid)

May 2, 1812: Weather continues very cold. (ibid)

- high water in Souris in May, in Red and on plains in June

May 21, 1812: people [sent to Souris River the day before to fish] from the Souris arrived...without success owing to the great flush of water. (ibid)

June 4, 1812: I returned up the [Red] river [toward Forks] with two men in a Canoe to look after our men who were coming down with horses. we found them 3 points above when we stoped and learned from them that the water was so deep in the plains that they could not take them farther down in consequence I sent 4 men down with the canoe & I returned to the fort, with our man & the horses to leave them in the care of some freeman till the water abates...very heavy rain. (ibid)

- fall entry in Pembina Journal indicates very high water for the year

October 10, 1812: no post down there [near the mouth of the Red River] is perfectly able to support itself unless they have an opportunity of catching a great number of fish in the fall- which the very high water of this year forbids me to expect. (Pembina Journal of Occurrences, HBCA B.160/a/4 1812/13)

1812-13 **- INCONCLUSIVE**

- freezeup and breakup dates for Red at Pembina not unusual

November 11, 1812: This day the [Red] river was set fast by the frosts of the last and preceding nights. (Pembina Journal of Occurrences, HBCA, B.160/a/4 1812/13)

April 9, 1813: The ice in the main [Red] river opened before the Fort. (Journal No. 2 of Miles McDonell, Fort Daer, Selkirk Papers, vol. 62, pp. 16813-16816)

April 15, 1813: The water in the [Red] river keeps rising much ice drifting. (ibid)

- no additional information about either the Red or Assiniboine Rivers

1813-14 **- NORMAL**

- freezeup in fall and breakup in spring appear to have been normal

November 8, 1813: the river takes across this morning. (Miles McDonnell's Journal No. 3, Fort Daer, Selkirk Papers, vol. 63, 16863)

April 23, 1814: the ice on Red R. broke up. (ibid, p. 16894)

- significant rainfall must have occurred in upper Red basin in August because the river was reported rising

August 13, 1814: Water rising fast in the river these 4 days from Rains in the Upper Country. (Peter Fidler's Journal, HBCA B.235/a/3 1814/15)

August 31, 1814: Heavy rain from 4 to 7 am & fell 2 inches & 6 tenths. (ibid)

- Assiniboine rising in early October implies significant September rainfall

October 6, 1814: water rising [in Assiniboine] very fast these 5 days. (ibid)

- there is very little information in general about river levels but none that would suggest that the rivers were very different from normal

1814-1815 **- HIGH**

- high water in Assiniboine in fall, 1814 (see 1813-14)
- very deep snow during winter 1814-15 (PART B)
- flooding in Red in spring, 1815 (PART B)
- lower than usual spring water level in Assiniboine (PART B)
- water levels began falling in June; exceptionally late spring

June 6, 1815: the water falling fast daily- very few leaves have yet made their appearance. Indians arrived from Lake Winnipeg say it is fast yet except a little water along the shore. (Peter Fidler's Journal, HBCA B.235/a/3 1814/15)

- shallow water on Assiniboine in August and on Red in October

August 29, 1815: Mr. McKay sent off his boat for Brandon with half a Cargo on account of the shallowness of the Assiniboine River. (Colin Robertson's Diary at Fort Douglas, Vol. 3 (1815), HBCA E/10/1)

October 8, 1815: The weather remarkably fine...I am afraid the Rafters [coming from Fort Daer] will have some difficulty on account of the lowness of the water [on the Red]. (ibid)

1815-16 **- LOW**

- low water on Red in October, 1815 (see 1814-15)
- late freezeup; mild, dry fall, 1815

November 24, 1815: they have had no snow at Fort Daer and the season has been altogether remarkably mild. (Colin Robertson's Diary, at Fort Douglas, Vol. 3 (1815), HBCA E/10/1)

December 8, 1815: there is no snow on the ground. (ibid)

December 12, 1815: The Wind South West. the weather extremely fine for this season of the year, indeed so much so, that for want of Snow the Indians cannot approach an animal. (ibid)

January 8, 1816: The weather uncommonly fine, our Cattle are feeding on the plains the same as in the fall of the year. (ibid)

- some subsequent snow but melted by very early spring

March 24, 1816: Fine weather, the snow has almost left us. (ibid)

March 30, 1816: very little snow left on the Ground, only in low places & in the thickets. (Brandon House Journal, HBCA B.22/a/19 1815/16)

- normal breakup of Red

April 22, 1816: The [Red] River entirely clear of Ice, but the Assiniboine is still fast, this is owing to the want of water to raise the ice from its old bank...The Ice moved in the Assiniboine River this afternoon. (Robertson's Diary, op. cit.)

- inconsistent descriptions of water levels in late May

May 29, 1816: water remarkably high in the Red River & low in this or the Assiniboine. (Brandon House Journal, HBCA B.22/a/19 1815/16)

May 29, 1816: The weather warm we had little or no rain this spring which makes the Rivers very low in this quarter. (Robertson Diary, op. cit.)

- very dry spring

May 30, 1816: The weather exceedingly warm, the ground almost parched up. (ibid)

- the Assiniboine was again reported as "shoal" on June 6 (Brandon House Journal, op. cit.)
- there are no further reports of water levels for the rest of the water year
- given the low water in the Red in the fall, the lack of snow by the late winter, the early spring, and Robertson's first-hand observation of low water on the Red, it appears that runoff must have been low, regardless of the peculiar May 29 comment in the Brandon House Journal.

1816-17 **- LOW**

- no information regarding water levels in spring
- very low water on Red and drought in July

July 12, 1817: water very low in the [Red] river. (Peter Fidler at Red River Settlement, in Brandon House Journal, HBCA B.22/a/20 1817-18)

July 20, 1817: heavy rain-water remarkably low in the [Red] river-& the crops exceedingly backwards...The Grass is also remarkably short & ground dry-all the little runs of water now Dry-so there is every reason to expect a bad Crop on account of the great want of rain-The Season has also been colder than usual. (Fidler, op. cit.)

July 30, 1817: Water very low in the [Red] River. (Fidler, op. cit.)

- many comments in August by Fidler about low water or lack of water between Forks and Brandon House (Brandon House Journal, op. cit.)

August 12, 1817: water very low here [at Brandon House] and the French Garden every bit as backward as those at the Forks, all for want of rain. (Fidler, op. cit.)

September 27, 1817: [the hay] is very short to what it [usually] is owing to the Dryness of the summer. (Fidler, op. cit.)

- despite the lack of information about the water levels in the spring, it seems that overall, the runoff must have been low.

1817-1818 **- LOW**

- early freezeup of Assiniboine in fall, 1817

October 23, 1817: The [Assiniboine] river froze over in the night being very early in the season... (Brandon House Journal, HBCA B.22/a/20 1817-1818)

- cold winter

January 18, 1818: These last two winters have been particularly severe and the Summers short, cold & little rain the crops not ripening as usual. (Brandon House Journal, HBCA B.22/a/20 1817/18)

- very cold weather reported throughout January and February in Hibernia (Fort Pelly) Journal (HBCA B.159/a/6 1817-18)

- rapid change in weather in March to early spring

March 9, 1818: Thawed much the plains almost entirely bare of Snow heavy rain this afternoon-Snow on the Ground on the level this winter 7 Days ago only 6 3/4 inches which is the least I have ever observed these 30 years past. The Ind. say it is deep 1/2 way between this & the Mandan villages...could not hawl any firewood for want of Snow. (Brandon House Journal, op. cit.)

April 1, 1818: Ice broke up in the Red River at Fort Daer being very early in the season [report from man just arrived from Forks]. (ibid)

April 8, 1818: [a man] could not proceed to Red Lake to Trade Sugar as the Snow was off the Ground. (ibid)

April 10, 1818: The Red River was open upon the 10th of April and the settlers arrived from Pembina the 15th of that month. (Letter, Alex MacDenell to Lord Selkirk, dated at Fort Douglas, July 20, 1818, in Selkirk Papers, vol. 15, p. 5192, PAM 175)

April 11, 1818: water very low [in Assiniboine] & no Snow. (Brandon House Journal, op. cit.)

- possibly normal water level in Assiniboine in mid-April but low water by early May

April 18, 1818: Ice driving [in the Assiniboine]...Water rose about 2 feet perpendicular this last week. (ibid)

April 21, 1818: Much Ice driving down the [Assiniboine] River & many drowned buffalo. (ibid)

May 18, 1818: these 2 last years the [Assiniboine] river has been very shoal... (ibid)

- widespread reports of low water through June and July

June 2, 1818: owing to the shoalness of the water [in the Assiniboine] & numerous Sand banks it was Sun Set before we reached Grants village [near Portage la Prairie]. (Peter Fidler's Journal, HBCA B.22/a/21 1818/1819)

June 8, 1818: water low in the Red River [at Forks], but rather More than in the N branch [Assiniboine]. (ibid)

June 20, 1818: the water [on the lower Red River] is very shoal. (ibid)

June 23, 1818: ...water low here [on Winnipeg River] but all the small rivulets falling in are entirely full of water owing to the very heavy rain that fell last night.- In the evening very heavy Thunder & a Deluge of rain-that lasted 2 Hours. (ibid)

June 26, 1818: ...came to the head of the Pinawa which the NW Canoes go down in years of very high water, now not an Indian light canoe could go down it without frequently carrying... (ibid)

August 25, 1818: very little water in White River now [tributary to Winnipeg River near Slave Falls]... (ibid)

August 30, 1818: The Fishery [in the Red] this Summer has been bad, owing to the very low state of the Water [in the Red]. (ibid)

September 1, 1818: water very low in the [Red] River-and a very dry season scarce a single shower of Rain all summer...These 3 Summers past remarkably little rain-as also very little Snow in winter-quite different from what it used to be. (ibid)

- a rise in the Red occurred in early September but the reports continued to emphasize low water

September 8, 1818: ...water rising fast in the Red River owing to heavy rains above. (ibid)

September 9, 1818: [Sturgeon] have been scarce all summer, which is attributed to the Shoalness of the water [in the Red]. (ibid)

September 17, 1818: little [goods] can be taken [to Brandon House] in Canoes the water very shoal in the Assiniboyne River. (ibid)

1818-19 **- NORMAL**

- relatively mild early winter with little snow

January 5, 1819: From November 20 to 22 there was a fall of snow, which has stayed on the ground; however, there is not more than a good six inches of it at Pembina, and eight leagues farther up [the river] almost none at all. The ice on the [Red] river began to take on November 13; we have not yet had any very cold spells. (Letter, Dumoulin, Pembina, to Plessis, Quebec City, in Nute, G.L. (ed.), 1942. Documents Relating to Northwest Missions. Minnesota Historical Society, Saint Paul, Minnesota, p. 176)

April 20, 1819: at Noon the [Assiniboine] river Ice floated past no rise scarcely in the water-many thick drifts of snow still unmelted-hot and windy. (Peter Fidler's Journal at Brandon House, HBCA B.22/a/21 1818/19)

April 22, 1819: All the Ice seems to have passed and the water [in the Assiniboine] is low for so soon in the Season. (Brandon House Journal, HBCA B.22/a/21 1818/19)

- the level of the Assiniboine rose gradually toward the end of April due to rain, snow and snowmelt - water levels appear to have been normal in Assiniboine
- water levels fluctuated through late April and May with alternating reports of rising and falling water
- by late May, levels were falling in both rivers

May 28, 1819: Water [in the Red] rose 1 foot last week. (Peter Fidler's Journal, HBCA B.51/a/2 1819/20)

May 29, 1819: Water [in the Red] falling a little. (ibid)

June 2, 1819: Water falling fast in the Assiniboyne River [observed from the Forks]. (ibid)

- in May, Fidler expressed the general opinion that the "country" was becoming drier

May, 1819: Wherever I have been and from information from the tribes I gather that the country is becoming drier than formerly. Numbers of small lakes have become good firm land with timber of various kinds but generally willows or poplar or ash is the first to produce. (Peter Fidler, quoted in Kavanagh, M. The Assiniboine Basin: A Social Study of the Discovery, Exploration and Settlement of Manitoba, Hammersmith, London, p. 46)

- by late June, the Red was again rising but the Assiniboine remained low and by late August, both rivers were low

June 22, 1819: Water rising fast from Red River-Assiniboyne river low. (ibid)

August 29, 1819: Water very shoal in both rivers. (ibid)

- the fluctuating late spring and summer flows in the Red indicate that rainfall in the early summer at least was sufficient to produce periodically rising water
- there are no references to droughts or excessively low water except in the Assiniboine and in the Red at the end of summer, a time when both rivers are normally low
- it seems most likely that runoff was within the normal range

1819-20 **- NO DATA**

- no information exists from the fall of 1819 to the fall of 1820

1820-21 **- NORMAL**

- the Red froze over on November 8, 1820

  November 8, 1820: The [Red] river was frozen over and the winter set in with severity. (West, J., 1824 [reprinted 1966]. The Substance of a Journal During a Residence at the Red River Colony. S.R.Publishers Limited, Johnson Reprint Corporation, N.Y., p. 22)

- very cold and unusually mild weather alternated throughout the entire winter

  January 7, 1821: Mild cloudy weather with heavy rain towards night, a circumstance that happens but very seldom in these parts, at this period of the Year. (Red River Journal, HBCA B.235/a/4 1820/21)

- winter precipitation appears to have been normal but considerable snow was reported in April
- breakup was late

  May 1, 1821: Cold cloudy weather with a fall of Snow...the Ice on the River got under way in the early part of the Day and did not stop until the River was quite clear. (Red River Journal, op. cit.)

- May and June were unusually cold

  July 2, 1821: An agreeable change has taken place in the scenery around us; the trees are breaking into leaves, and many plants are in blossom, where, but a short time ago, every thing bore the aspect of winter. (West, op. cit.)

- there are no references to the rivers from May to July but there seems to have been a distinct change in the weather to abundant storms and intense heat beginning in June

  June-August, 1821: ...The intense heat we have had since the first of June has been the cause of frequent and abundant storms, always accompanied by terrible thunder. (Letter, Destroismaisons, St. Boniface, to Plessis, Quebec City, in Nute, G.L. (ed.), 1942. Documents Relating to Northwest Missions. Minnesota Historical Society, Saint Paul, p. 328-9)

- by late August low water was reported in rivers on the divide between the upper Mississippi and Red basins

  August 31, 1821: It is further asserted by the Indians that the water in these remote streams, and upon these rapids, is at all times shallow, but it is particularly so this season...They concurred in opinion that, in the present low state of the water on these summits [travel was impractical]. (Schoolcraft, H.R., 1855. Summary Narrative of an Exploratory Expedition to the Sources of the Mississippi River in 1820. Lippincott, Grambo, and Co., Philadelphia, Pa., reprinted, 1973, Kraus Reprint Co.; Millwood, New York, p. 132-3)

- with the exception of the last, there are no references to low water, drought etc. and it seems that runoff was probably in the lower part of the normal range

1821-22 **- NORMAL**

- the Red froze in early November and winter seems to have been severe, at least in late January

November 8, 1821: Set fast in Ice going to Pembina in Boats at the big point. (Diary ascribed to Paul Reyburger, Red River Settlement, HBCA E8/9 1821/22)

January 28, 1822: ...another man was frozen to death on the Plains; others lost their toes in the severity of the winter & all [Swiss settlers at Pembina] are suffering privations. (West, J., 1824. The Substance of a Journal During a Residence at the Red River Colony. reprinted 1966, S.R.Publishers Limited, Johnson Reprint Corporation, N.Y., p. 71)

- a thaw began in mid-March

March 14, 1822: The river at present produces a very few fish but that cannot be expected to continue beyond a week as the current is now getting so Strong owing to the melting of the snow that it is unsafe to set nets. (Governor George Simpson's Journal, HBCA D/3 1821/22)

March 24, 1822: ...compelled to walk through the plains up to the knees in Slush & water 16 miles to the Fort on acct. of the bad state of the Ice. (Simpson Journal, op. cit.)

March 25, 1822: The thaw continues...shouldn't be late before the River breaks up, & is clear of Ice, so as to prevent catching Sturgeon...Saw two geese, the sure harbingers of spring. (West, J. The British North American Indians with Free Thoughts on the Red River Settlement, 1820-1823, PAM MG7 B1 M33, p. 37)

- more severe weather followed in April, causing a late spring and delaying breakup until April 28

- George Simpson reported that winter had been severe with heavy snow in the region of the Red River Settlement but milder and little snow to the south

May 20, 1822: ...in this part of the Country and to the Northward we have had an unusually severe Winter with an extraordinary quantity of snow nearly 3 ft Deep, whereas to the Southward the Season has been mild and little or no snow so that the unfavourable state of the season prevented our Cattle from taking their usual Northern tour... (Simpson's Journal, op. cit.)

- there are no reports on the Red or Assiniboine Rivers but the upper Mississippi was reported high in August

August, 1822: This summer the water was very high and, working along with our keelboat, we found it difficult to work with poles, as we could find no bottom and had to pull along by the brush a good deal of the time. We were three days getting above the mouth of the Missouri. (Philander Prescott in Parker, D.M., (ed.), 1966. The Recollections of Philander Prescott: Frontiersman of the Old Northwest, 1819-1862. University of Nebraska Press, Lincoln, Neb., p. 43)

- the absence of any reports of low water suggests conditions were within the normal range

1822-23 **- LOW**

- freezeup in the fall of 1822 was early, beginning in late October

October 22, 1822: Cold and windy weather. Some of our men in a boat started this morning for Pembina but were obliged to return in consequence of the [Red] River being frozen over. Those who were to go to Netley Creek, but also failed for the same reason. (Red River Journal, HBCA B.235/a/5 1822/23)

- grass fires burning over very large area

October 31, 1822: ...Fire still raging in the plains, and the Country burnt in every direction... (Fort Ellice Journal, HBCA B.235/a/5 1822/23)

November 1, 1822: [some Stone Indians] inform us that the whole way between this and the Saskatchewan River is burnt. (ibid)

November 13, 1822: The prairies are nearly all burned; meat will be scarce this winter... (Letter, Dumoulin, Pembina, to Plessis, Quebec City, in Nute, G.L. (ed.), 1942. Documents Relating to Northwest Missions. Minnesota Historical Society, Saint Paul, Minnesota, p. 378)

- dry fall, milder weather in late November

November 29, 1822: The season has been so dry that the prairies are burned almost completely, a condition which will probably cause us to experience famine at least as far as meat is concerned...The fire not only traversed the Red River area, but also all the prairies as far as Fort des Prairies whence the company gets much of its supplies...I did not receive his letter until the day before All Saints; and even then the rivers had for some twelve days been frozen solid enough in spots to carry men and even horses; it is true that subsequent mild weather has caused the ice to melt, and the rivers are now open. (Letter, Bishop Provencher, St. Boniface, to Bishop Plessis, Quebec City, in Nute, op. cit., p. 379-80)

- cold weather and heavy snowfall in mid-December

December 19, 1822: Weather still so severe that it requires the work of six or seven men to furnish the different dwelling houses with firewood. In the evening John McLeod and [?] arrived from Pembina with two horses but owing to the depth of the snow and the consequent badness of the roads they were under the necessity of leaving about 400 lbs fresh meat about half way from this. (Red River Journal, op. cit.)

- very mild winter through most of January
- severe cold alternated with mild weather through February and early March
- thaw began in March and greatly reduced the snowpack but colder weather and snow in April and low water delayed breakup

April 14: Visited two nets which are set in an opening of the ice, but caught only 5 small fish. The sturgeon have not yet made their appearance, the water being so low that the ice cannot drift tho much broken. (Red River Journal, op. cit.)

- significant snow in late April
- May was dry

May 26, 1823: Fine warm weather. The growth of our crops...is much retarded for want of rain. (ibid)

May 30, 1823: Wind southerly blowing fresh with clouds of dust and smoke. Weather excessively

warm. (ibid)

- some rain in early June but complaints of drought beginning

June 6, 1823: Fine warm weather, the seed crop comes on but slowly on account of the drought. (ibid)

- by August, the Red and other water bodies throughout Manitoba and Northwest Ontario are described as unusually low

August, 1823: ...but the river at that time was unusually low [Keating on Red River just below Pembina]. (Keating, W.H., reprinted 1959. Narrative of an Expedition to the Source of St. Peter's River, Lake Winnipeek, Lake of the Woods etc. Performed in the Year 1823. Ross & Haines Inc., Minneapolis, Minnesota, p. 96)

August, 1823: It is probable that this, as well as the other rapids of the river, is at times much finer than it was when we saw it, for the stream was considered low [Keating on Winnipeg River]. (Keating, op. cit.)

August, 1823: ...it is usual for voyagers to make a small portage over this point. It did not exceed one hundred yards at the time we crossed it. Our guide says that it is often under water so that the canoes pass without difficulty. This requires a rise of five or six feet above the level of the waters at that time [Keating on Lake of the Woods]. (Keating, op. cit.)

- the drought of early season confirmed by Provencher in September

September 16, 1823: Last year's harvest provided some of the comforts...that we had not had before. This year the harvest will bring little drought having killed the grain to some extent and even more the garden stuff, a part of which did not come up until July, when rain finally came to moisten the earth. (Letter, Bishop Provencher, Red River, to Bishop Plessis, Quebec City, in Nute, op. cit., p. 407)

- low water was also experienced in Minnesota in fall, 1823

October 31, 1823: It now began to be late in the fall...The [Minnesota] river was quite low, and we experienced considerable trouble in getting over, or around, sand bars, or shoals... (Reminiscences of Mrs. Ann Adams, Minnesota Historical Collections, 2:124, quoted in Parker, D.D., 1964. Lac Qui Parle: Its Missionaries, Traders and Indians. South Dakota State University Press, p. 241)

- there is some evidence that spring runoff may have been below normal and certainly there was widespread drought and low water in the summer

1823-24 **- HIGH**

- low water in late summer, 1823, due to summer drought

August 13: ...but the [Red] river [near Pembina] at that time was unusually low. (Keating, W.H., 1959 (reprint). Narrative of an Expedition to the Source of the St. Peter's River, Lake Winnipeek, Lake of the Woods, etc. Performed in the Year 1823. Ross & Haines Inc., Minneapolis, Minnesota, p. 37)

- spring runoff unknown but inferred to be normal because of lack of mention
- heavy summer rainfall in 1824 with high waters (and possible flooding) throughout summer of 1824 (PART B)

1824-25 **- VERY HIGH**

- wet summer and fall, 1824

January 2, 1825: [The people are starving] owing to the failure of their crops last Autumn from heavy rains and frost. (Red River Journal, HBCA B.235/a/6 1824/25)

- high water in spring, 1825 (PART B)
- flooding or high water on both Red and Assiniboine throughout summer, 1825 (PART B)

1825-26 **- VERY HIGH**

- late summer flooding, heavy rains in fall of 1825 (PART B)
- largest flood on record in spring, 1826, continuing into early summer (PART B)
- high water reported into fall,1826 (PART B)
- high spring runoff in Assiniboine (PART B)

1826-27 **- VERY HIGH**

- high water levels and heavy rainfall in fall (1826)
- high runoff in spring (1827) with minor flooding (PART B)
- abundant rainfall in late July, August and September, 1827 (PART B)
- second peak in late summer with very high water in September, 1827 (PART B)

1827-28 **- VERY HIGH**

- very high water levels in fall, 1827, and heavy late-summer rain (PART B)
- significant flooding in spring, 1828 (PART B)
- significant late summer rainfall, 1828

August 15, 1828: The weather mild and showery... a tolerable crop [of barley], except on the low ground which was much destroyed by the water standing on it after the frequent heavy rains. (W. Cochran's Journal, PAM MG7 B2 CMS A85)

August 22, 1828: The most awful night I ever witnessed...The rain which fell...being now standing on the ground...to a depth of three inches. (ibid)

1828-29 **- NORMAL**

- high water level in Assiniboine in fall, 1828

October 7, 1828: Want of food induced our people to make several attempts at erecting fish weirs in the Rapid River, which unfortunately proved unsuccessful owing to the unusual height of the waters-The same result followed similar attempts in the Assiniboine River... (New Brandon House Journal, HBCA B.22/a/22 1828/29)

- dry weather and very extensive grass fires in October, 1828

October 9, 1828: Fine weather but the fire in the Plains is not far from the Fort. (Red River Journal, HBCA B.235/a/12 1828/29)

October 10, 1828: Dry windy Weather by which the conflagration of the Plains is increased to a furious degree. (New Brandon House Journal, op. cit.)

October 20, 1828: Fine weather, in the evening we saw the fire Blazing on the opposite side of the River the wind blowing very strong from the South. (Red River Journal, op. cit.)

- relatively late freezeup in fall, 1828

November 23, 1828: The Assiniboine River set fast-The small lakes have been so for some time back. (New Brandon House Journal, op. cit.)

- cold and mild weather alternated through December to February, becoming generally mild with thawing in March (additional citations in PART B)

March 2, 1829: we have had a slight thaw today for the first time and it only requires a slight one, indeed, to render the plains, which have burned in Autumn, impassable with sleds; there being on such grounds scarcely any snow during the winter. The weather since the 15th Ult. has been changeable sometimes tolerable, at others, cold, windy and snowy-This day, however, has brightened the scene, and afforded us a glimpse of spring. (New Brandon House Journal, op. cit.)

March 27: much astonished at the mildness of the atmosphere, the clouds were dense and dark like thunder clouds in summer passing from North to South. About 8 o'clock...it began to thunder, which was succeeded by heavy rain, which continued till about four in the afternoon when the wind veered to the North and brought us large flakes of snow. (William Cochrane's Journal, PAM MG7 B2 CMS A85)

- normal breakup in mid-April (PART B)
- Swan River reported as high on April 18 (PART B) but Assiniboine falling by April 25 (PART B)
- low water reported in Red on May 1

May 1, 1829: The Weather fine the water [in the Red] very low for the season. (Red River Journal, op. cit.)

- showers reported on about 1/3 of the days at the Red River Settlement in May and June, occasionally heavy
- the Assiniboine reported as very high in the Red River Settlement on June 12 and 17 but falling again at the end of June (PART B)
- July and August were warm with only occasional rain; water levels falling faster

July 9, 1829: The weather very warm, & the water falling very much. (ibid)

July 31, 1829: The weather fine & the water falling very much. (ibid)

- by September, the water level in either the Red or the Assiniboine was low and late summer dryness had hardened the ground

September 9, 1829: The weather fine & the water very low. (ibid)

September 25, 1829: Froze hard last night...the Weather fine the Water [in Red and/or Assiniboine?] very low. (ibid)

September 26, 1829: Weather still fine owing to the dryness of the Season the Ground is so hard that the farmers are unable to Plough. (ibid)

- despite the reports of low water (possibly on the Red) in the late summer, the absence of similar statements in the spring and the very high water levels in the Assiniboine in response to rainfall in May and June suggest that overall runoff was within the normal range

1829-30 **- NORMAL**

- October, 1829, was rather stormy with frequent rain and snow

October 26, 1829: The weather fine. Doctr. Toods [?] men who left [today] were detained at White Horse Plain owing to the fall of snow. (Red River Journal, HBCA B.235/a/13 1829/30)

- freezeup of the Red was early

October 30, 1829: Bird arrived from York Factory but was Oblig'd to leave his boat at the entrance of the River, several People have crossed the River on the ice in different places. (Fort Garry Journal of Occurrences, HBCA B.235/a/3 1829/30)

- snow began to accumulate significantly in January (PART B) and by early March there was apparently a heavy snowpack (PART B)
- thawing conditions began in late March and breakup of both rivers occurred at a normal time in mid-April (PART B)
- the level of the Assiniboine was very high in late April and May due to both snowmelt and abundant rain in May (PART B)
- although there is no direct reference to it, it is reasonable to assume that the level of the Red was also high, or at least above-average, given the heavy rain reported in the Red River Settlement (PART B)
- from mid-June to the end of July, there was virtually no rain at the Settlement and the ground was described as "parched" (PART B)
- however, rain was reported on about 1/4 of the days in August and early September at Fort Pelly (no records from Red River Settlement), including several heavy falls and snow on August 9 (!) and September 6

August 9, 1830: Rained last night and ended in a fall of Snow this morning. (Fort Pelly Journal, HBCA B.159/a/12 1830-31)

August 14, 1830: Constant rain last night and continued so all day. (ibid)

September 4, 1830: Loud thunder with heavy rain. (ibid)

September 6, 1830: The Ground was all covered this morning with Snow and a pretty Sharp Frost. (ibid)

- although there are no direct references to the Red, the high water on the Assiniboine in May and June and the apparent heavy rainfall over Red River Settlement in May and June, and the return of rain in the Fort Pelly region in August and early September suggest that runoff was most probably within the normal range.

1830-31 **- NORMAL**

- very mild weather throughout most of winter, 1830-31

December 18, 1830: The weather has been uncommonly fine so far, no snow, little frost & the river not yet all fast. [Letter, Alexander Ross, Red River Settlement, to James Hargrave, dated Dec. 18, 1830, in The Hargrave Correspondence, 1821-1843. Greenwood Press, Publishers, New York, 1968, p. 61)

January 5, 1831: The weather continuing mild all winter was much against us ... [making salt at Salt Lake 50 mi. south of Pembina]. (Campbell, R., 1958. Two Journals of Robert Campbell (Chief Factor Hudson's Bay Company) 1808-1853. Limited edition, Seattle, Washington, p. 67)

January 18, 1831: Weather mild thawing in the middle of the day about the doors. (Fort Pelly Journal, HBCA B.159/a/12 1830-31)

- very little snow reported from Fort Pelly at least until mid-February and mild weather continued with strong thawing in early March
- significant snowfall at Fort Pelly in March
- colder temperatures began in early April and continued through most of April, making spring very late

April 23, 1831: Thawing a little on the Height of the day...appearance of it being a late Spring and it is much to be feared the Swan River will be very Shallow as the portion of Snow already Melted is entirely dried up with the frost. (ibid)

April 27, 1831: fine Clear weather all the Snow is nearly off the Ground...an Indian...informs us that the Ice is drifting down the Rivers, Which appears to be rising fast. (ibid)

April 28, 1831: Snowing this morning and continued at intervals most of the day. Blowing fresh from the NE...we are told that the rivers are rising. commenced ploughing but could not continue as the ground is too much frozen. (ibid)

- the upper Assiniboine experienced a short freshet but was falling by the end of April
- May was very dry and alternately warm and cold

May 20, 1831: the Spring is most backward Northerly Winds month after month and little or no appearance of Vegetation. Lake Winnipeg is as solid as in the Depth of Winter and McMillan says that he is ploughing through Ice instead of Soil. (Letter, George Simpson to John G. McTavish, Moose Factory, dated Red River Settlement, 20 May, 1831, HBCA B.135/c/2, p. 66)

- heavy rains (and some snow) in Fort Pelly region throughout June and July and into August caused the Assiniboine to rise to a very high level

June 5, 1831: Raining most of the day...Garden... coming on very Slowly by reason of the cold weather. (Fort Pelly Journal, HBCA B.159/a/13 1831-32)

June 7, 1831: Weather became more Settled the water continues rising; our Hay Ground of Last year is in one complete Lake. (ibid)

June 8, 1831: ...the River is too High for Crossing either on foot or on Horseback. (ibid)

June 12, 1831: weather Cloudy raining at times. the River Still rising all the low Ground Covered with water. (ibid)

June 17, 1831: Rained most of the night very warm to day...Millar went to the Crossing place...and Says the River has rose about 4 feet and thinks from the Height of Water that the Gardens at Lower fort is all overflowed. (ibid)

June 28, 1831: The Same Sultry weather...nearly all the Gardens below are destroyed by the High waters. (ibid)

July 2, 1831: heavy rain during the night...the Ground is so completely drenched with Water that nothing can be done to [the potatoes] the Hay Ground is also covered with water. (ibid)

July 24, 1831: Raining most of the day, was not the River So High we might be able to obtain a livelyhood on fish but there is no possibility of making a Barrier. (ibid)

August 20, 1831: the rest of us Carrying the Hay that was cut to dry Ground as the Late rains has almost Set it a float. (ibid)

- no information exists about the Red but given the apparently normal spring runoff and very wet summer in the Assiniboine basin, it is not unreasonable that the Red had at least normal runoff

1831-32 **- NORMAL**

- severe weather in December, 1831, with little snow

December 20, 1831: Unusually severe has it hitherto been from 10 to 28 below zero during what has passed of this month with little or no Snow... (George Simpson to Donald Ross, quoted in Williams, G. [ed.], 1975. Hudson's Bay Miscellany, 1670-1870. Hudson's Bay Record Society, Winnipeg, Manitoba, p. 160)

- strong thawing beginning in late March at Fort Pelly produced an early freshet

March 23, 1832: Thermometer rose as high as 37 above 0. the Snow nearly dissolved...Rained a little this Evening. (Fort Pelly Journal, HBCA B.159/a/13 1831-32)

March 30: ...the Small Creeks nearly overflow their banks, the Snow, except in the woods & Sheltered places was entirely dissolved and very little water in the Plains. (ibid)

- breakup of the Red occurred in mid-April

April 18, 1832: The [Red] River being now clear of ice, as far as Netley Creek, and most of the snow thawed. (Rev. W. Cochran's Journal, PAM MG7 B2 CMS A85)

- by late April, fears were expressed at Fort Pelly about the possible low water in the Assiniboine

April 25, 1832: Remarkable dry Weather, the rivers getting very low and we fear there will be much difficulty in getting everything down. (Fort Pelly Journal, op. cit.)

- heavy snow fell in early May but generally warm, dry weather was reported from both Fort Pelly and the Red River Settlement
- the summer seems to have been rather wet

June 14, 1832: Heavy and incessant rains are falling in this neighbourhood. The ground is deluged, the wheat and barley look sickly and many potatoes which are planted on wet soil are rotting. (Cochran Journal, op. cit.)

July 1832: The whole season has been unfavourable. we had heavy falls of rain & hard frost up to the 20th of May. About the 24th the weather became genial. This left us very little time to put down a crop. About the 10th of June heavy and constant rains commenced... (Cochran Journal, op. cit.)

- very early frosts occurred in the Red River Settlement and as far south as southern Minnesota

August 19, 1832: This morning the air was excessively cold, a thick hoar frost covered the ground and the stagnant waters of the swamps were frozen...The potato tops are blasted. (Cochran's Journal, op. cit.)

August 30, 1832: A most unexpected frost last night which completely cut down everything in the shape of vegetation; there are many sorrowful faces at Red River to day as by far the greatest part of the wheat is in an unripe state. (Rev. David Jones Journal, PAM MG7 B2 CMS A92)

September 1, 1832: The third day out it commenced raining and we had a tremendous storm and all at once a little before sundown the wind changed from the southeast to west and blew a gale for an hour or two. It was very cold and it actually froze ice, and the next morning there was not a leaf hardly but what was frozen stiff, and all the gardens spoiled [at Traverse de Sioux]. (Philander Prescott, in Parker, D.M. (ed.), 1966. The Recollections of Philander Prescott, Frontiersman of the Old Northwest, 1819-1862. University of Nebraska Press, Lincoln, Nebraska, p. 134)

- although it is unlikely that streamflow was ever particularly high in either the spring or summer, neither are there indications that the Red or the Assiniboine were unusually low and there seems to have been ample spring rainfall to compensate for a reduced freshet and produce runoff in the normal range

1832-33 **- NORMAL**

- early fall was cold and "disagreeable" but mild weather in late October and November delayed freezeup until late in the month

November 26, 1832: It is a surprising proof of the mildness of the season that no snow remained on the ground yet, which generally is the case every year six weeks before this (Rev. David Jones' Journal. PAM MG7 B2 CMS A92)

- heavy snow and some cold weather occurred in early January but mild weather returned

before the end of the month

January 21, 1833: Weather unseasonably mild-the snow quite soft and the eaves of the houses in the middle of the day dripping like in spring weather. (ibid)

- late February was exceptionally cold but very warm weather occurred in early March and alternated with cold weather until mid-March when a thaw set in lasting into the first week of April

March 16, 1833: fine weather...snow fast diminishing. (Fort Pelly Journal, B.159/a/14 1832-33)

March 29, 1833: I proceeded to the Stone Fort on horseback the Snow being nearly all melted away and too much black earth for the cariole to draw...The water has been collecting on the sides of the river on the surface of the ice for some time but the middle was considered hard and strong...my horse went through...The rush of water under the ice was tremendous. (Jones Journal, op. cit.)

- colder weather and snow after the first week of April delayed breakup of the Assiniboine at Fort Pelly until April 23

- heavy rain fell in late April and particularly in early May

May 6, 1833: [late in the evening] the rain was falling in torrents and the swamps were so deep that my horse could not carry me. I was obliged to plunge through them on foot. In some places I sink above the knees in withered reeds and water. The frost was still in the bottom... (Rev. W. Cochran's Journal, PAM MG7 B2 CMS A85)

- rain, often described as "constant", was reported at Fort Pelly on all but 4 days from May 4 to May 19, causing a rise in the Assiniboine

May 19, 1833: raining great part of day the [Assiniboine] River is now unusually high and Still Rising. (Fort Pelly Journal, op. cit.)

- there are no other records until September but it appears that the summer continued to be wet

September 7, 1833: from the heavy and constant rain during the Summer this part of the country may be said to have been under water in Several places... (ibid)

September 20, 1833: ...Since the commencement of harvest, there has been a great and incessant struggle. The weather has been boisterous, gloomy and moist. (Cochran's Journal, op. cit.)

September 28, 1833: The wind veered to the north and brought such a torrent of rain upon us, as I have never before witnessed, the plains are deluged, and the creeks run as deep as in the spring...(ibid)

- there is little reference to the rivers, apart from the high state of the upper Assiniboine in May, but the abundant rainfall suggests that runoff would have been normal, at least

1833-34 **- LOW**

- cold weather set in early in October, 1833, at Fort Pelly

October 18, 1833: Weather excessively cold for this season of the year. (Fort Pelly Journal, HBCA B.159/a/15 1833-34)

October 20, 1833: fine Weather ice drifting in the [Assiniboine] River. (ibid)

- virtually no snow fell at Fort Pelly through November

November 7, 1833: ...no snow and the ground hard froze. (ibid)

November 21, 1833: [Indians unable] to follow the tracks of animals from want of snow. (ibid)

- temperatures fluctuated between cold and mild through January and lack of snow continued to be a problem at Fort Pelly throughout February

February 17, 1834: ...no snow on the ground [on trip to Beaver Creek] nor has there been sufficient for trains any time during the winter. (ibid)

- some snow fell in March but was usually quickly removed by subsequent milder weather
- spring was very early

April 2, 1834: the geese are flying; the trees are budding; the earth appears again. (Rev. W. Cochran's Journal, PAM MG7 B2 CMS A85)

April 9, 1834: the snow was now nearly all dissolved and the surface of the earth beginning to be soft. This is the earliest spring I have seen in Red River, it is just one month earlier than it was the year of the Deluge. (ibid)

- a short-lived rise occurred in the upper Assiniboine at Fort Pelly (April 11) but by April 16, it was falling

April 16, 1834: ...River falling fast. (Fort Pelly Journal, op. cit.)

April 21, 1834: ...the State of the water [still falling off] makes me anxious to get [the boats] down as soon as possible. (ibid)

- the weather at Fort Pelly in May was mixed cool and warm with some rain
- there are no records between mid-May and mid-August; there had been sufficient rain to produce an excellent harvest at the Red River Settlement

September 9: Our harvest which is finished...is good. The people do not complain. The wheat and all the grains are very beautiful...Here we have had great heat and beautiful weather for the entire growing and harvest season . (Letter, J.N.Provencher, Eveque de Juliopolis, St. Boniface de la Riviere Rouge, to Monsieur J. Signay, Eveque de Quebec, 4 Septembre, 1834, in Lettres de Monseigneur Joseph-Norbert Provencher, Premier Eveque de Sant-Boniface, Bulletin de la Societe Historique de Saint-Boniface, vol. III, 1913, Imprimerie du Manitoba, Saint-Boniface, Man., p. 141-142)

- in late September, the water levels were described as low

September 26, 1834: cold severe weather arrived at mid-day Just 20 days from Red River Settlement where I left every thing quiet with abundant crops had some delay in the Lakes from Stormy Weather also in the Rivers from the unusual low state of the water... (Fort Pelly Journal, op.

cit.)

- there is no indication of severely low water and certainly no drought but from the early ending of the freshet on the Assiniboine, the late summer reference to low water in the rivers, and the lack of any evidence for abundant rainfall, it is likely that runoff was somewhat low

1834-35 **- INCONCLUSIVE**

- the early fall, 1834, was very cold with snow at Fort Pelly and early freezeup of the Red

October 25, 1834: Was prevented from visiting the Indian Settlement owing to the state of the River, which is now froze but not sufficiently strong to carry the weight of a person. (Rev. W. Cochran's Journals, PAM MG7 B2 CMS A85)

- milder weather with little snow occurred in November

December 1, 1834: The Settlement has not been healthy this fall, though the weather has been unusually fine;...The weather is still mild, and not snow enough yet to run our carioles... (Letter, Thomas Simpson, Fort Garry, to James Hargrave, dated Fort Garry, 1st Decr 1834, in The Hargrave Correspondence, 1821-1843. Greenwood Press, Publishers, New York, p. 160)

- the first heavy snowfall occurred in early January

January 10, 1835: The weather cold and stormy, the snow drifting to suffocation the track invisible by the heavy fall of snow. (Cochran Journals, op. cit.)

February 27, 1835: We have had our full share of cold this winter which has been a strange one, December intense cold and thaws by turns, January mild, even warm, and February most severe; this very morning we had it 20 below zero and blowing a gale at same time. (Letter, Thomas Simpson, Fort Garry, to James Hargrave, dated Fort Garry, 27 February 1835, in The Hargrave Correspondence, op. cit., p. 187)

- March was generally mild and snow conditions were very different in the upper Assiniboine and Red River Valley; the snow almost disappeared at Fort Pelly and to the west but remained significant near the Red River Settlement

March 19, 1835: ...the snow has nearly disappeared. (Fort Pelly Journal, op. cit.)

March 20, 1835: The weather exceedingly stormy, a strong wind blowing from the north with much snow which rendered the track invisible, the drift flying thick almost to suffocation...The drifts in many parts were as high as the tops of the bushes. (Cochran Journal, op. cit.)

March 30, 1835: ...the Snow has now entirely disappeared in the woods as well as the plains. (Fort Pelly Journal, op. cit.)

April 3, 1835: The track to the Indian Settlement is so full of drifts of snow, that it requires about four hours to perform the journey. (Cochran Journal, op. cit.)

- much colder weather occurred after April 10 and continued to the end of April and into May
- the upper Assiniboine was expected to be low

April 21, 1835: therm 22 above Stormy Weather...from the Rivers being still fast we are now at a stand...[sending goods by water] I believe will be entirely out of the question as there is every prospect of the Rivers being unusually low. (Fort Pelly Journal, op. cit.)

April 26, 1835: Cold disagreeable Weather with Snow forwarded the Batteaux to Beaver Creek in consequence of the very low state of the water. (ibid)

May 13, 1835: Still blowing Strong from the South some rain fell in course of the day...Jack Easter returned from Beaver Creek he was nine days getting there he has not seen the water so low for 40 years. (ibid)

- by June, excessive heat and dryness was reported in Red River Settlement

June 5, 1835: We had a short winter and not very cold. The snow was all melted at the end of March. We had the reverse in April and May. Now the weather is too dry. (Msg. J.N.Provencher, Eveque de Juliopolis, to Msg. J.I.Lartigne, Eveque de Telemesse, dated Riviere Rouge, 5 juin, 1835, PAM MG7 D1)

- very little additional useful information is reported in July and August; some comments continue to refer to excessive heat and in August, frequent rain, which must have been sufficient to produce an abundant harvest
- the upper Assiniboine was clearly very dry but snow conditions in March and April in the Red River Valley seem to have been quite different; although it is likely that runoff was somewhat low, there is insufficient information to be confident of this

1835-36 **- NORMAL**

- winter set in early, with cold weather, rain, snow and freezeup in October

October 20, 1835: A perfect winter day, snowing and drifting furiously from morning to evening. (Rev. David Jones' Journals, PAM, MG7 B2 CMS A92)

October 25, 1835: Was prevented from visiting the Indian Settlement owing to the state of the River which is now froze but not sufficiently strong to carry the weight of a person. (ibid)

- severely cold weather apparently continued through the entire period from late October though much of March with no indication of a break

March 12, 1836: Weather continues in its full severity and no symptom of winter breaking up. (ibid)

- by the end of March, however, strong thawing conditions set in

March 26, 1836: Rain and sleet all day & the snow melting fast...the ground covered with slush more than half knee deep. (ibid)

March 31: The roads are now nearly impassable with melted snow. (ibid)

- early April brought considerable precipitation and although breakup occurred in mid-April, the latter half of the month was colder

April 3, 1836: ...the morning was very gloomy. All the ground covered with snow excepting a few patches of earth here and there which had been laid bare by the sun of the last two days... (ibid)

April 6, 1836: A heavy rain last [night] and subsequently a warm morning; but the wind veered to the North in the middle of the day and brought on sleet and snow again. (ibid)

April 12, 1836: A good deal of snow fell last night again but the air is generally warm. The ice moved a few yards in the afternoon. (ibid)

April 15: The ice went off for good and all to day. Weather piercingly cold. (ibid)

April 29, 1836: Weather seems warm in earnest at last. (ibid)

- May was dry and by the end of the month, complaints of drought began

May 28, 1836: ...the drought however is severe and keeps every thing very backward. (ibid)

May 30, 1836: The drought is very severe; there was a slight shower with thunder in the afternoon but it soon passed away again. (ibid)

- rain fell in June and July in sufficient quantity to permit crop growth

June 6, 1836: Soon after retiring last night we were disturbed by the approach of a thunder storm and the sound of abundance of rain, which nature has been gasping and panting for, for weeks past. (ibid)

June 30, 1836: We were overtaken between Grantstown and this little Settlement by a most terrific thunderstorm which drenched us terribly. (ibid)

July 3, 1836: while at Church a heavy rain came on which continued till after I returned from the Middle Church... (ibid)

August 18, 1836: Commenced reaping barley. It is not a great crop, the drought early in the spring prevented it succeeding according to expectation. (Rev. W. Cochran's Journals, PAM MG7 B2 CMS A85)

- a day after this last entry, much of the crop was killed by frost

August 19, 1836: On the 19th of August we were visited by a most destructive frost which destroyed the reward of the farmer as to [wheat]; it was truly a gloomy morning the whole of the vegetable world drooped and blackened as the sun grew warm...All garden seeds have been destroyed so that our prospects for next summer are most desolate... (Letter, Rev. D. Jones to Rev. Wm. Jowett, Church Missionary House, Salisbury Court, London, dated Red River Settlement, July 21, 1836, PAM MG7 B2 CMS A92)

- the remainder of August and September were generally cool and frequently wet
- apart from the very dry late May and June, there is nothing to indicate abnormal conditions in the rivers. On October 13, 1836, Provencher reported that according to Father Belcourt at Pembina, winter was long and hard, there was more snow than usual and there were fears of another flood (which didn't happen). Thus it seems that the freshet at least was probably normal.

1836-37 **- LOW**

- the fall and early winter of 1836 was relatively mild

December 1, 1836: The autumn had been long and beautiful, and the snow had not yet cast its white mantle upon the earth. (Simpson, Thomas, reprinted 1970. Narrative of the Discoveries of the North Coast of America, vol. 1, 2nd. ed., Canadiana House, Toronto, p. 26)

November-January, 1836-37: The season continued cold, drizzly, and frosty, till the latter end of October...after that, however, the weather became unsually mild and pleasant, insomuch that men were whistling at the plough on the 12th of November, and hauling their carts without snow, till the 14th of January 1837. (Ross, A., 1957 [reprint]. The Red River Settlement: Its Rise, Progress, and Present State. Ross and Haines, Minneapolis, Minnesota, p. 188)

- mild weather was reported into early February but became cold by mid-February, and March was very cold and stormy with considerable snow

February 28, 1837: ...bad walking-snow deep [between Red River Settlement and Pembina]. (Martin McLeod in Nute, G.L., 1922. Diary of Martin Mcleod. Minnesota History Bulletin, vol. 4, p. 408)

March 4, 1837: Came a long distance today, snow deep and very heavy...[on south branch of Park River]. (ibid, p. 409)

March 6, 1837: Bad walking. Snow deep...The further Southward we come, the more snow we find [south of Pembina]. (ibid, p. 410)

March 17, 1837: ...suddenly...a storm from the North came on that no pen can describe...I was then completely wet through for a shower of sleet had accompanied the storm...The night came, the storm continued unabated...[near lake Traverse]. (ibid, p. 413)

- the snow seems to have been greater in the southern Red River Valley (south of Pembina) than at the Red River Settlement since William Cochran reported

April 24, 1837: Very little snow has fallen during the winter, this has exposed the ground to all the ... influence of a dry cold which is more pernicious to agriculture than any summer drought. There are fissures in the earth sufficiently wide at the surface to admit the foot of a horse or ox. These run in every direction dividing the ground into small pieces of two or three yards square, thus all the moisture has evaporated and the frost has gone to an unusual depth. As there is no water from the melting snow and no rain to enter the earth and thaw it, all beneath 4 inches on the surface...down to a depth of 4 feet is as hard and dry as rock, and cold as ice. (Rev. W. Cochran's Journal, PAM MG7 B2 CMS A85)

- breakup was late and cold dry weather continued into May

April 13, 1837: ...The ice in the river is as solid as in December. Since the year of the deluge I have not seen so late a spring. (Rev. D. Jones' Journal, PAM MG7 B2 CMS A92)

April 26, 1837: Since ...[April 13] the weather has been very favourable and gloomy. This day the ice moved about twenty yards and then choked up again. (Cochran Journal, op. cit.)

April 30, 1837: ...crossed the river in a canoe [at the Indian Settlement] the ice had moved down toward the Lake. (ibid)

May 10, 1837: The state of the weather has kept every thing in a most desponding state. Cold bleak winds from the North and every morning ice half an inch thick. (Jones Journal, op. cit.)

May 22, 1837: The weather continues dry, cold and stormy. Very little of the wheat that we have sown is germinating...At present a great quantity of the wheat which was sown 3 weeks ago, is as dry as when in store. (Cochran Journal, op. cit.)

- warm weather and some rain didn't arrive until June but frost continued to be common at night

June 6, 1837: Still nightly frosts destroying every hope of the husbandsman. (Jones Journal, op. cit.)

June 8, 1837: At night there was thunder and rain and in the afternoon the object of many prayers was granted in a fine general rain which fell without violence and without ceasing the whole of the evening. (ibid)

June 11, 1837: This evening we were favoured with a weighty shower of rain that saturated the ground 4 inches in depth. Few can conceive the gratitude that was felt in many a bosom to God for this refreshing shower. We have had no rain since September and scarcely any snow during winter consequently everything is parched, and no appearance of summer... (Cochran Journal, op. cit.)

June 29, 1837: There was a severe frost last night which cut down all the potatoes in many places! (Jones Journal, op. cit.)

- in July, Provencher reported

July 4, 1837: ...The weather has been too cold and too dry. There wasn't [much] snow and this spring there wasn't much moisture in the ground... (Letter, J.N.Provencher, St. Boniface de la Riviere Rouge, to Monseigneur J.I.Lartigne, Eveque de Montreal, 4 July 1837, PAM MG7 D1)

- sufficient rain fell in July to improve the crop prospects

October 13, 1837: In the spring, I may say to the latter end of June, all vegetation was checked by cold and drought. After the rain began to fall it came in such torrents that all the corn and potatoes were prostrated to the earth, and before they would have time to recover and look up, there would be another heavy shower, carried by tempestuous wind and hurled upon them... (Cochran's Journal, op. cit.)

- September was very wet

September 6, 1837: ...heavy rain and miry track. On arrival [at the Indian Settlement] found the roof of our house had fallen in from the weight of water that lodged in the thatch. (ibid)

September 11, 1837: The weather extremely unfavourable for harvest, the ground covered with water. (ibid)

September 17, 1837: The weather rainy and extremely cold...The water is higher than the knee of the horse. (ibid)

September 22-23, 1837: ...the weather wet and cold. (ibid)

- despite the late summer precipitation, the apparent lack of snow in the winter and spring drought suggest that water levels and runoff were probably low. This is supported by the general reference to low waters in the rivers in the Fort Pelly Journal in September.

September 14, 1837: ...an unusual long voyage [from York Factory due to] the low State of the Water in the Rivers after leaving Norway House, particularly Shoal River... (Fort Pelly Journal, HBCA B.159/a/17 1837-38)

1837-38 **- NORMAL**

- the wet conditions of September, 1837, continued through most of October, which was also cold

October 8, 1837: Most disagreeable Weather with thunder lightning & Constant rain. (Fort Pelly Journal, HBCA B.159/a/17 1837-38)

October 10, 1837: towards Mid day it commenced Snowing which continued without ceasing the remainder of the day. (ibid)

October 15, 1837: returned late, for miles the track was covered with water, froze thinly on the top, the ice too weak to carry the horse. (Rev. Wm. Cochran's Journal, PAM MG7 B2 CMS A85)

- several heavy snowfalls occurred at Fort Pelly in November
- by mid-January, the snow was being reported as deep

January 14, 1838: Travelling is now very heavy from the great depth of snow. (Fort Pelly Journal, op. cit.)

January 17, 1838: ...the track invisible in many parts with fresh drifts...(Cochran Journal, op. cit.)

- February brought more snow and generally cold weather

February 24, 1838: ...a constant fall of snow with Stormy weather which continued the whole of the Journey [to Fort Ellice]. (Fort Pelly Journal, op. cit.)

- mild weather and thawing conditions began after the first week of March and continued until the end of the month when an early spring arrived

March 29, 1838: geese and Ducks Seen an extraordinary occurrence at this Season the River is also reported open in Several places. (ibid)

March 31, 1838: ...frogs heard another unusual occurrence in the Month of March. (ibid)

April 4, 1838: ...the [Assiniboine] River was perfectly clear of ice. (ibid)

April 4, 1838: ...the river impassable. (Cochran Journal, op. cit.)

April 8, 1838: Went down to the Settlement. The track miry and the water in the swamps covered with new ice...The river being here in a much worse state than I anticipated, the ice being piled up about twenty yards from the shore. (ibid)

- the water in the Assiniboine was reported to be high

April 12, 1838: ...as the [Assiniboine] River is now high [some men] had to be crossed with a Canoe. (Fort Pelly Journal, op. cit.)

- additional snow fell from mid-April onward but by April 26, the Assiniboine at Fort Pelly was falling

April 26, 1838: ...the snow has now disappeared without adding to the Water in the [Assiniboine] River which Still continues to fall off. (ibid)

- the level of the Red is not clear but was probably normal

May 2, 1838: The wind blowing strong from the north, the waves running high was nearly swamped in crossing the River. (Cochran Journal, op. cit.)

- the first half of May was dry but rain and snow fell at both Fort Pelly and the Red River Settlement in the second half

May 19, 1838: in consequence of heavy rain in the morning I was unable to take my departure till after Mid-day. (Fort Pelly Journal, op. cit.)

May 22, 1838: The ground covered with snow. (Cochran Journal, op. cit.)

May 30, 1838: Heavy rain all day... (ibid)

- June was hot (although a frost occurred on June 7) and wet

June 2, 1838: The heat is intense. The morning delightful after a heavy rain. (Rev. D. Jones' Journal, PAM MG7 B2 CMS A92)

June 21, 1838: Thunder and heavy rain. All our crops are covered with water. (Cochran Journal, op. cit.)

June 30, 1838: Tremendous thunder and torrents of rain which I fear will much injure the crops. (Jones Journal, op. cit.)

- several heavy rainfalls were reported among the few entries for July; no entries exist for August
- the (brief) high water reported in the Assiniboine, the apparently not-unusually noteworthy state of the Red in the spring, and the wet period in late-May and June suggests runoff in the normal range

1838-39 **- NORMAL**

- the few entries that exist for the fall of 1838 suggest that October and November were cold with significant snowfall
- cold and excessively cold was generally reported in December and January, again with significant snowfall

January 13, 1839: ...Snow very deep. (Red River Journal, HBCA B.235/a/14 1839)

January 28, 1839: ...the weather stormy and excessively cold, snow drifting so thick as to render the track invisible. (Rev. W. Cochran's Journal, PAM MG7 B2 CMS A85)

- temperatures rose in February and rapid thawing was reported at mid-month

February 19, 1839: ...rapid Thaw Snow disappearing fast (Red River Journal, op. cit.)

- by the end of February, however, more snow fell on several days and temperatures had become cold again
- several heavy snowfalls occurred in the first half of March with some periods of mild weather; by late March, thawing conditions became general and spring arrived in the first

week of April

March 31, 1839: The ice on the river covered with water. (Cochran Journal, op. cit.)

April 7, 1839: The plains covered with water and ...melted snow, thinly crusted with ice. (ibid)

April 8, 1839: River open in places. (Red River Journal, op. cit.)

- May was alternately very warm and cool and relatively dry but with some rain toward the end of the month
- June was very hot and no rain was reported; when rain arrived in early July, it was welcomed

July 4, 1839: Returned in the evening, heavy rain and loud thunder...The rain was much required, the fields were yawning for it. Many of these openings in the wheat were sufficiently wide to admit the hand to be pushed down 8 inches. Had the drought continued many days longer, my fields of wheat would have been dried from the roots. (Cochran Journal, op. cit.)

- by mid-August, the summer was described as dry and warm

August 12, 1839: This has been one of the finest Summers I have ever passed in the Indian Country- The weather was exceedingly dry and warm, but the heavy dews at night prevented its being injurious to the crops which are more abundant than anticipated. (Letter, John Ballendeen, Fort Garry, to James Hargrave, dated Fort Garry, Red River Settlement, 12th August, 1839, in The Hargrave Correspondence, 1821-1843. Greenwood Press, Publishers, New York, p. 304-5)

- rain fell on 11 of the 16 days from August 25 to September 9 but very little fell after that to the end of September
- although there are few references to water levels, there seems to have been sufficient late winter snowfall to produce spring runoff in the normal range

1839-40 **- NORMAL**

- the fall of 1839 was not especially severe and after rain in early October, precipitation was light

December 4, 1839: The track so rough and so little snow upon it... (Rev. W. Cochran's Journal, PAM, MG7 B2 CMS A85)

- from late in December through February, the weather was generally very cold with abundant snow

January 18, 1840: The wind was blowing strong and snow as fine as dust drifting along made it impossible to see the track. I know it would be scarce possible to get the Cariole through the deep snow... In the afternoon the wind abated considerably so that I was not much troubled by the drifting of the snow but what had fallen was so deep that my horse...could scarce get through it. (J. Smithhurst's Journals [at Indian Settlement], PAM MG7 B2 CMS A96)

February 6, 1840: At this time the ice upon the river in front of my house is near 4 feet thick... (ibid)

February 22, 1840: It has been a most winterly day...the wind was blowing so strong and the snow drifting in such a way that it was with great difficulty the boy could get my horse to face it. (ibid)

- there is no information about March but thawing conditions were occurring by early April

April 4, 1840: ...I had a most disagreeable ride owing to the Thaw. The horse was up to the knees in mud and water most of the way. (ibid)

- most of April seems to have been cold, however, and breakup of the Red was late

April 13, 1840: It has been a cold winterly day the wind blowing fresh from the North with drifting snow. (ibid)

April 25, 1840: ...the River is in such a state that it is unsafe to walk across and the ice is not sufficiently broke up to cross in a canoe... (ibid)

- May weather seems to have been normal, with some rain but by the end of the month, "oppressive" heat was reported and June and July were very dry

June 6, 1840: In the early part of the spring. the weather had been so very cold and backward, that serious apprehensions were entertained that the crops would be indifferent, but such a favourable change took place, about the latter part of May, that they improved so rapidly as to be...of a very promising aspect. (Cochran's Journal, op. cit.)

July 14, 1840: The weather intensely hot and dry. (ibid)

August 6, 1840: Our summer here has been rather extraordinary, from the 1st of June to the 1st of this month we had hardly a shower of rain... (Letter, Thomas Bunn to Mrs. Ann Bayley, dated Red River, Aug. 6, 1840, PAM MG2 C19)

- the summer precipitation, while apparently small, was adequate to produce a good crop

September 1, 1840: ...got all our wheat stacked. The harvest has been a very favourable one... (Smithhurst Journals, op. cit.)

- the combination of abundant winter snowfall and the late slow melt suggests that runoff would have been in the normal range, despite the apparent dryness of the summer

1840-41 **- NORMAL**

- winter conditions began in October and November continued cold with several falls of snow

October 29,1840: The snow began here the 18 October and it again covered the ground which was frozen; the rivers are taken and we will have a long winter. (Letter, J.N.Provencher, Eveque de Juliopolis, St. Boniface de la Riviere Rouge, to Monseigneur J. Signay, Eveque du Quebec, 20 Octobre 1840, in Lettres de Monseigneur Joseph-Norbert Provencher, Premier Historique de Saint-Boniface, vol. III, 1913, Imprimerie du Manitoba, Saint-Boniface, Man., p. 193)

- these conditions persisted with only occasional mild spells until mid-March

January 23, 1841: It has been a most winterly day...the snow having drifted nearly the height of the fences. (J. Smithhurst's Journals [at Indian Settlement], PAM MG& B2 CMS A96)

February 5, 1841: The weather has now been so excessively severe that people if at all unwell are unable to stir out... (ibid)

February 14, 1841: Track had Got into a drift of snow where my horse stuck fast. (ibid)

March 7, 1841: ...rather longer than usual on the journey owing to the snow being deep and no track yet formed. (ibid)

- thawing began in late March but colder weather in April caused spring to be remarkably late

March 22, 1841: Returned home through half melted snow, in many parts above the horse's knees. (Wm. Cochran's Journals, PAM MG7 B2 CMS A85)

April 11, 1841: Snowing thick, river dangerous, the open places concealed by the new fall of snow...Returned home through deep snow. (ibid)

April 20, 1841: We have every appearance of warm weather the snow has melted very fast to day and the ground is now almost bare. (Smithhurst Journal, op. cit.)

- considerable rain and some snow fell in the last week of April and by May 1, wintery conditions remained

April 28, 1841: It rained nearly all day... (ibid)

April 29, 1841: The wind is now blowing a gale and it has been snowing and drifting all day as if it were the month of Jan. The ground is again quite solid and the snow several inches deep. (ibid)

April 30, 1841: We have now arrived at the end of April without any appearance of winter leaving us. Every thing looks just as it did at Xmas all locked up in solid ice. (ibid)

May 1, 1841: The roads were worse than ever I saw them being for the most part covered with water that was frozen over an inch thick... (ibid)

- breakup of the Red didn't occur until May 6-12

May 6, 1841: ...after a spring which held the ice on our river to May 6. (Letter, J.N.Provencher, Eveque de Juliopolis, St. Boniface de la Riviere Rouge, to Monseigneur I. Bourget, Eveque de Montreal, 13 July 1841, PAM MG7 D1)

May 9, 1841: The ice in the river being unsafe to walk upon and not sufficiently open to pass in a canoe I have been unable to get across. (Smithhurst Journal, op. cit.)

May 11, 1841: ...The ice has to day been floating out of the river in large blocks from two or three feet thick. (ibid)

May 12, 1841: ...The river is now clear of ice and there is an appearance of the weather continuing fine. (ibid)

- warmer weather arrived about May 6; June and July were very hot and stormy with several heavy falls of rain (and some hail)
- August and September were warm with some (but not abundant) rain
- the abundant winter snowfall, precipitation in late April, and late breakup, as well as the significant summer rainfall, all suggest that runoff may have been above-average but within the normal range
- this is supported by Alexander Ross's petition to the Council of Assiniboia in 1842 (see 1841-42, Spring entry)

1841-42 **- NORMAL**

- freezeup and winter conditions began in late October, 1841, but freezeup wasn't completed until November 16

October 25, 1841: I was detained some time in crossing the river, as it had frozen sharp during the night and I was compelled to wait while the ice was broken to make way for my canoe. (J. Smithhurst's Journals, PAM MG7 B2 CMS A96)

November 1, 1841: Winter has commenced in good earnest to day. The wind has been blowing a gale from the north with a heavy fall of snow. (ibid)

- additional snow fell in late November and December, producing a deep snowpack by early January

January 6, 1842: The snow was so deep and no track I could scarce get on. (ibid)

- cold weather with some further snowfall persisted with virtually no break until late March-early April when a general strong thaw produced a very early spring

March 27, 1842: ...going all the way [to Grand Rapids] by way of the river. There was a good deal of water upon the ice owing to the magnitude of the snow. (ibid)

April 2, 1842: The general thaw seems to have commenced in consequence of which it is not practical to travel by the river... (Journal of Abraham Cowley, PAM MG7 B2 CMS A86)

April 7, 1842: The ice in the river has broken up to day and is consequently impassable... (ibid)

April 10, 1842: The river is now tolerably clear of ice and the Indians were able to cross. (ibid)

- spring runoff seems to have been considerable

Spring: ...in the years 1841 and 1842 the public road, behind my dwelling, was so overflowed from

the swamps behind, during the spring, that it was impossible for man or beast to pass, and was so almost every spring. (Petition by Alexander Ross to Council of Assiniboia, May 27, 1856, quoted in Oliver, E.H. [ed.], 1914. The Canadian North-West, Its Early Development and Legislative Records. Publication of the Canadian Archives No. 9, Government Printing Bureau, Ottawa, p. 421)

- information is scanty after May; southern Minnesota was dry and water levels were reported to be diminishing over several years

August 31, 1842: ...Last year [1841] [the Indians'] corn suffered from drought...They never planted so much corn...as this season; but the cold weather in May...the several frosts between the 10th and 20th June, and the subsequent dry weather, have so entirely destroyed it, that is doubtful whether they will have as much as one sixth, or even one eighth as much as last year...For the last few years the waters in all the prairies northwest of Traverse de Sioux have been rapidly diminishing. Where a few years since, were beautiful lakes several miles in circumference, now, not a drop of water can be found. Even streams dignified with the name of river, in which the Indian was accustomed to paddle his canoe, have entirely disappeared...The muskrat ponds have of course dried up... (Report of the Commissioner of Indian Affairs for 1842, Serial 413, p. 427-431, quoted in Parker, D.D., 1964. Lac Qui Parle: Its Missionaries, Traders and Indians, South Dakota University Press, Brookings, S.D., p. 214-5)

- there is no indication from the few entries available that conditions were this dry in the Red River Settlement or that the crop was affected

1842-43 **- NORMAL**

- winter set in strongly in early November with severe temperatures and heavy snow

November 11, 1842: ...had the latter part of the journey [home from Grand Rapids]...in a heavy storm of snow. (J. Smithhurst's Journals, PAM MG7 B2 CMS A96)

November 12, 1842: The winter has now commenced in good earnest, the themometer at Zero [Fahrenheit] and the river frozen over. (ibid)

- from November to March, the winter was severe with many references to "excessive" cold and temperatures of -30°to -50°F
- snowfall was apparently abundant

January 8, 1843: ...the track [was] heavy in consequence of the drifts of snow carried together by the storm of yesterday. (ibid)

February 12, 1843: [attendance was poor] owing partly to the deep snow that has fallen recently... The thermometer being 40° below Zero... (ibid)

February 16, 1843: The thermometer was this morning 52° below Zero. [This] excessive cold...has now lasted nearly three weeks... (ibid)

March 6, 1843: It commenced snowing when we left the Fort and continued the whole day, sometimes drifting to such an extent that we could not see the track. (ibid)

- a snowy winter was also reported in southern Wisconsin

The winter of 1842-43 was one of the severest winters I ever saw. The snow fell first about a foot and a half [deep], and went off mostly and fell again over a foot, and mostly went off again. And in

February [snow] fell again, near two feet, again making in all nearly four feet... (Philander Prescott in Parker, D.M. (ed.), 1966. The Recollections of Philander Prescott, Frontiersman of the Old Northwest, 1819-1862. University of Nebraska Press, Lincoln, Neb., p. 173)

- thawing conditions began in early April and the snowmelt was augmented by additional snow and rain; breakup was relatively late

April 7, 1843: The thaw is now going on very rapidly and there being so much water I find it difficult to move about. (Smithhurst Journal, op, cit.)

April 14, 1843: The morning was unfavourable in consequence of a heavy fall of snow mixed with rain... (ibid)

April 23, 1843: The river being full of floating ice is still impassable. (ibid)

April 24, 1843: In the afternoon the weather was so unfavourable owing to a cold north wind and excessive rain... (ibid)

April 29, 1843: It has been snowing all day and the snow drifting with a strong north wind till at times I could scarce see twenty yards from the house... (ibid)

- good weather in early May dried the ground sufficiently to permit agricultural operations to begin but snow fell again in mid-May
- several very heavy rainfalls were reported in June, August, and September (no records exist for July)

June 15, 1843: The rain fell in torrents so that we could not see two yards from the door. (Smithhurst Journal, ibid)

June 25, 1843: ...it rained in torrents for two hours... (ibid)

September 4, 1843: [near White Horse Plain] there came a most awful storm of thunder, lightning and rain with scarce any intermission. The rain came down in torrents...The storm lasted for a full hour... (ibid)

- runoff was probably above-average but in the absence of any reference to the state of the rivers, probably within the normal range

1843-44 **- NORMAL**

- freezeup occurred in October

October 12, 1843: Scarcely had the weary pilgrims [arrived at Red Lake Mission than there was] such a sudden drop in the temperature that it resulted in the immediate freezing over of the lake... (Schell, Rev. J.P., 1911. In the Ojibway Country: A Story of Early Missions on the Minnesota Frontier. Chas. H. Lee, Publishers, Walhalla, North Dakota, p. 17)

October 29, 1843: The ice being now sufficiently strong people cross the river without danger. (J. Smithhurst's Journals [at the Indian Settlement], PAM MG7 B2 CMS A96)

- stormy weather and heavy snow were typical from December to early February

January 1, 1844: The weather exceedingly stormy, and track almost impassable from the large quantity of snow which had fallen. (W. Cochran's Journals, PAM MG7 B2 CMS A85)

January 23, 1844: The storm continued...the drifts are so high that in some places I seem walking between walls of snow that I cannot see over. (Smithhurst Journal, op. cit.)

February 12, 1844: ...in the afternoon a strong gale set in from the north bringing with it a heavy drift of snow. During the five winters that I have spent in this country I certainly never saw any thing to equal this storm... (ibid)

- conditions improved in March and a strong thaw was occurring by early April

April 4, 1844: This and the last two days have been very warm. We have travelled the whole distance from the Pembina River to [White Horse Plain] on foot, in snow and water. (Peter Garrioch Journal 1843-47, PAM MG7 C38, p. 13)

April 6, 1844: It rained the whole morning... (Smithhurst Journal, op. cit.)

April 8, 1844: It has been a fine warm day again...Nearly all the snow is melted. (ibid)

April 12, 1844: The ice has been clearing away to day. The river is passable though there is still a good deal of floating ice. (ibid)

- freshet runoff appears to have been substantial

April 13, 1844: Proceeded to the Riviere Isles des Bois...After going about a quarter of a mile in water of from one to two feet, I came to a creek which took my ox nearly up to the back. I continued about another quarter of a mile through water as before, when I came to another creek, which from its depth and narrowness as well as from the rapidity of its current, I did not like to encounter with my ox and cart...[After getting across] I now hastened to get to dry land and proceeded several hundred yards with that view, tho water up to my knees. At this moment I came in contact with another creek which appeared to be more formidable than any I had crossed...{after crossing] we did not however go more than another hundred yards when he [the ox] again sunk to his belly [near Red River toward Pembina River]. (Garrioch Journal, op. cit., p. 15)

- travelling south from Pembina in June, Garrioch encountered rather high waters in west-bank tributaries of the Red and into Minnesota and reported considerable rain

June 26, 1844: Crossed the Sioux River. The carts in crossing this River were almost entirely submerged. One of Peter Hedin's carts was turned clean over by the force of the stream with a woman and two children in it. (ibid, p. 18)

July 1, 1844: Left Lac qui Parle and crossed the Chippewa River. The water in this River was 8 or 10 feet above low water mark... (ibid, p. 18)

- July, August and September appear to have been normally warm with sufficient rain to produce an excellent crop
- the apparently ample freshet and the high runoff in June suggest that runoff for the year would probably have been above-average but is classified as normal because there is no clear indication that the Red was unusually high

1844-45 **- NORMAL**

- freezeup and the first permanent snowcover occurred in October

October 18, 1844: the ground is covered with snow and it is very cold. (J. Smithhurst's Journals, PAM MG7 B2 CMS A96)

October 28, 1844: The river being sufficiently frozen to admit of crossing... (ibid)

- fall water levels were reported as good on the northern sections of the fur trade route

From the favourable State of the Water throughout the lower rivers, the Several ingoing Brigades passed Norway House for Winter quarters at an earlier date than usual. (Letter, Alex Christie to Arch. Barclay, London, dated Fort Garry, Red River Settlement, dated Fort Garry, 31 December, 1844, in HBCA A/11/95 1829-1853)

- no information exists from late-December, 1844, to March, 1845
- several heavy snowfalls were reported in early March and by mid-March a thaw had begun

March 7, 1845: A heavy fall of snow, and very stormy. (Peter Garrioch Journal 1843-47, PAM MG2 C38, p. 42)

March 11, 1845: Another great fall of snow. (ibid, p. 42)

March 16, 1845: Strong north wind and it thaws at a noble rate. Sleet in the evening; snow in abundance before bed time. (ibid, p. 42)

- snow and rain fell in April and cold weather delayed complete breakup until April 23

April 3, 1845: It blows and drifts to day like a February day. (ibid, p. 45)

April 4, 1845: Wet morning...The track very miry from the heavy rain which had fallen. (W. Cochran's Journal, PAM MG7 B2 CMS A85)

April 13, 1845: The ice upon the River being now covered with water which is in some places deep... (J. Smithhurst's Journal [at the Indian Settlement], PAM MG7 B2 CMS A96)

April 20, 1845: The ice in the river is at length broken up but has not yet moved to clear out. (Smithhurst Journal, op. cit.)

April 23, 1845: At last we have the pleasure of seeing clear water. (ibid)

April 25, 1845: It fell about 2 inches of snow the last night and continued to snow all this day. (Garrioch Journal, op. cit., p. 49)

April 29, 1845: Has been raining all day... (Smithhurst Journal, op. cit.)

- May appears to have been extremely wet

May 1, 1845: Quite stormy and some more rain. (Garrioch Journal, op. cit., p.49)

May 11, 1845: The storm which commenced last night at sun set increased in violence towards midnight and the quantity of rain which fell has been so great that every level piece of ground is covered with water and the farm is now half under water... (Smithhurst Journal, op. cit.)

May 12, 1845: Weather wet and stormy. (Garrioch Journal, op. cit., p.49)

May 13, 1845: In the evening it commenced raining and continued till the following morning. (Garrioch Journal, op. cit., p.53)

May 19, 1845: Returned in the evening through heavy rain. (Cochran Journal, op. cit.)

May, 1845: In 1845, the water [in a newly constructed drain] widened the drain and carried off the bridge and fence. (Petition by A. Ross to the Council of Assiniboia, May 27, 1856, quoted in Oliver, E.H., 1914. The Canadian North-West, Its Early Development and Legislative Records. Publications of the Canadian Archives No. 9, Government Printing Bureau, Ottawa, p. 422)

- wet prairies were reported in southern Minnesota in late June

The prairies were very wet and the streams all full, which delayed my arrival at 'Traverse de Sioux' till June 22. (Captain Edwin Sumner, quoted in Parker, D.M., 1964. Lac Qui Parle: Its Missionaries, Traders and Indians. South Dakota State University Press, Brookings, S.D., p. 128)

- little information is available about July and August; it appears to have been hot but not otherwise unusual. Crops were described as average
- the apparently normal freshet and wet May-June period indicate runoff was at least in the normal range, and possibly above-average

1845-46 **- NORMAL**

- late September, October and early November, 1845, were relatively wet and not cold

November 13, 1845: We are expecting the winter to set in with all its severity daily, it is nearly a month later than in some years... (W. Cochran's Journal, PAM MG7 B2 CMS A85)

- freezeup was rather late, between November 19-22

November 19, 1845: Heavy showers of snow. Large pieces of ice were drifting down the River... (ibid)

November 22, 1845: This evening the river at this place became a sheet of transparent ice. (Peter Garrioch Journal 1843-47, PAM MG2 C38, p. 59)

- snow was reported on several days but apparently not in great quantity

January 5, 1846: There has been very little snow fallen, consequently the tracks up the banks of the River are too slippery for oxen to haul loads. (Cochran Journal, op. cit.)

- very mild weather in late January removed whatever snow had fallen

January 22, 1846. This day has been quite an April one. The wind has been from the south and continues as strong and warm the present moment. (Garrioch Journal, op. cit., p.63)

January 24, 1846: The wind still to the South. This day has been altogether an April one. The wind has dissolved so much of the snow that water begins to stand in pools at the doors and the eves of barns hang down with length of icicles...It was so wet to day that I was obliged to put on boots in the afternoon. (ibid, p.64)

January 26, 1846: The roads on land were almost entirely bare. (ibid, p.64)

- February seems to have been cold and stormy but mild weather returned in early March, continuing to the end of the month with a heavy snowstorm on March 18-19

March 5, 1846: Got home a little after sun down under a heavy fall of snow. (ibid, p.70)

March 7, 1846: The snow begins to run down into running liquid. (ibid, p.70)

March 11, 1846: A very great part of the road from The Devil's Creek to the R. River was entirely bare. (ibid, p.70)

March 19, 1846: The storm of wind and snow which began last night at sun set has continued without intermission all day. (Smithhurst Journal, op. cit.)

- spring weather returned in April, with considerable precipitation

April 3, 1846: This day the thaw commenced accompanied by much rain. All the roads are deluged with water and scarcely passable. (ibid)

April 5, 1846: The track nearly impassable in many places. The water which had been formed during the warm days of the previous week was frozen over but not sufficiently to carry the weight of the horse. Every two or three steps he would go through the ice and sink above the knees in water & mire. (Cochran Journal, op. cit.)

April 6, 1846: The wind has again got round to his favourite quarter, the Old North. It commenced to snow and drift immediately after breakfast and it continues so to this moment which is bed time. (Garrioch Journal, op. cit., p.73)

April 7, 1846: Today a heavy snow storm. (Cochran Journal, op. cit.)

April 9, 1846: A great part of the road is covered over with ice in consequence of the late rains and subsequent frosts. (Garrioch Journal, op. cit., p.73)

April 17, 1846: Yesterday poured down rain; and this day it snows and drifts like ah that! (ibid, p.74)

- the river broke up between April 21-27

April 21, 1846: About this time the River broke up opposite the Orkney Cottage. (ibid, p.74)

April 26, 1846: ...Church was very thinly attended in consequence of the river having become again impassable. The ice from the Assiniboine River has been floating down to day. This generally passes two or three days after the opening of the Red River. (Smithhurst Journal, op. cit.)

April 27, 1846: The ice has moved away the river is now clear. (ibid)

- May was hot with no rain reported. June, July and August appear to have been normal summer weather but hot, with some heavy falls of rain reported; in August, Thomas Bunn reported

August 8, 1846: Our Winter was much as usual, rather severe, but our Summer has been stormy. Last month particularly, very frequent storms of Thunder & lightning. (Letter, Thomas Bunn, Red River, to Mr. Wm. Bayley, London, in Bayley, D., 1969. A Londoner in Rupert's Land: Thomas Bunn of the Hudson's Bay Company. Moore & Tiller, Chichester, England and Peguis Publishers, Winnipeg, p. 80)

...the crops generally last autumn were exceedingly unproductive, more particularly the wheat and Potatoes, arising principally from the excessive heat in the early part of the summer followed by mill-dews towards the end of July... (Letter, Alex Christie to A. Barclay, London, dated Fort Garry, Red River Settlement, 23 Nov., 1846, HBCA A11/95 1829-1853)

1846-47 **- NORMAL**

- the fall of 1846 was mild. Although snow fell on October 18 and ice appeared in the river on October 27, the river did not freeze until November 22

November 22, 1846: Winter has now commenced. Last night the river froze over and is now impassable ice not yet strong enough to bear walking upon. (J. Smithhurst's Journal [at the Indian Settlement], PAM MG7 B2 CMS A96)

- heavy snow fell in early December and very cold weather set in by mid-December

December 1, 1846: It commenced to snow and blow about 12 o'clock the last night and continued all this day the same. (Peter Garrioch Journal 1843-47, PAM MG2 C38, p. 81)

December 6, 1846: Though the weather was severely cold & the ground covered with three feet of snow the Rapids Ch. was exceedingly crowded...The River was not frozen completely so that sometimes horse & sometimes the cariole went through the ice. (Journal of Robert James, PAM MG7 B2 CMS A92)

December 15, 1846: ...the weather is now very cold. (Smithhurst Journal, op. cit.)

- with the exception of a brief milder period late in the month, January was extremely cold

January 20, 1847: The cold daily and steadily increased up to the 20th of January last when the Thermometer indicated the lowest point during the Winter, 47° below zero. (Diary of Colonel J.F.Crofton, Commander of the First Red River Expedition, 1846-7, Winnipeg Public Library, Ca 971.274 c, p. 27)

January 27, 1847: The wind has been south to day, and the weather has been milder than usual. The whole of the present month, with the exception of the last three or four days, has been cold to the Extreme. No year within the remembrance of the oldest settlers has been so cold as this has been. (Garrioch Journal, op. cit., p.83)

- February was mild with considerable snow, and much snow fell in early March

February 1, 1847: The weather was so mild yesterday that the Public road on the river was entirely cut up, by horses running on it as usual, on account of the snow becoming quite soft and nearly thawing. (ibid, p.83)

February 15, 1847: The snow was so deep and the road consequently so bad that the oxen scarcely dragged home one past each. (ibid, p.83)

February 23, 1847: Weather quite mild during our absence but a great deal of snow; and a good deal of thaw. (ibid, p.84)

March 2, 1847: Snow falls in abundance to day, and the wind being high, we had quite a drifty day. (ibid, p.85)

March 8, 1847: The storm [which began on the 7th] continued nearly the whole night so that the drifts were so large that I have had several men employed to day in cutting tracks... (Smithhurst Journal, op. cit.)

- although thawing conditions began in early April, the month was generally cold and snowy, till late in the month, with a late breakup

April 5, 1847: The thaw is now commenced and it is not an easy thing to move about. (ibid)

April 11, 1847: The spring here is a most unpleasant season...I had a dreadful ride through... snow & pools of water...(ibid)

April 17, 1847: ...the Winter generally speaking was unusually Severe and so far the Season continues extremely backward for every purpose of Agriculture. (James Journal, op. cit.)

April 18, 1847: The cold weather has returned and we are fearing another fall of snow. It was so cold today...that I could hardly keep my teeth from chattering and the men were all trembling...Strange enough, the birds, which a day or two ago, were going northward, have today been flying southward, not finding the water open on Winnipeg, nor the snow off the swamps where they feed. (Crofton Diary, op. cit., p.21)

April 20, 1847: We have had a heavy fall of snow last night and part of this day; the last struggle I hope of winter..This fall of snow we lament as it will probably extend to Pembina. (ibid, p.23-24)

April 21, 1847: The snow lay this morning half a foot thicker than yesterday, but at 9 the sun burst out, and there has been a rapid thaw all day. The water is now rushing down the river banks and flowing over the ice... (ibid, p.24)

April 23, 1847: The ice on the river has in some places become dangerous, and the thaw has swelled the many small water-courses into impassable torrents. The weather most genial today. (ibid, p.28)

April 25: The Red River broke up last night, the ice having been burst by a strong flood, evidently caused by the melting of the snow to the southward...In the course of this day the Assiniboine gave way... (ibid, p.30)

April 26: The heat today is quite extraordinary. It is summer heat...The ice is flowing fast in very broken masses, down the flooded rivers... (ibid, p.31)

April 27, 1847: The ice has moved away and the river is now clear. (Smithhurst Journal, op. cit.)

April 28, 1847: The south wind and hot sun are melting down the snow and ice rapidly. The prairies are uncovered as far as I can see. (Crofton Diary, p.33)

- May was generally cold and dry (but with snow on May 9-10)

May 10, 1847: The ground is today covered with snow but the first sun-shine will melt it. (ibid, p.42)

May 20, 1847: The weather today is rather milder but cold winds still chill all nature. The large Lakes are still frozen over. (ibid, p.50)

May 21, 1847: The west wind today has brought a warmer temperature...The Colonists are all croaking for rain. This month though called by the Indians the 'Frog Month', has heard no croaking except from the Colonists. (ibid, p.50)

May 23, 1847: It is said by the inhabitants, that the present cold and dry weather is most unusual at this season... (ibid, p.51)

- some rain fell in late May and early June but the river was observed to be low and concerns were being expressed for the crop

June 7, 1847: We have of late been much inconvenienced by the lowness of the river. Neither boats nor canoes can get near solid ground and the people have to land in the mud and where they sink almost up to the knee. (Smithhurst Journal, op. cit.)

June 16, 1847: the dryness has been felt since last year the ground has not had enough moisture to germinate a part of the grain... (Letter, Msg. J.N.Provencher, Eveque de Juliopolis, a Msr. Jean-Charles Prince, Eveque de Martyropolis, dated St. Boniface, 16 Juin, 1847, PAM MG7 D1)

- rain in July averted crop failure but the negative effects of the extreme dryness of the early growing season continued to be stressed by commentators and low water levels were noted by others

August 9, 1847: [The] prospects with respects to the crops have considerably improved since the beginning of the season, where a long continued drought, gave us much reason for apprehending a still more extensive failure than that of last year... (Letter, Alex Christie, Fort Garry, to Archibald Barclay, Hudson's Bay House, London, HBCA A11/95 1829-1853)

August 16, 1847: [The wheat] is not more than a foot high the ears very small...nearly all spring sown wheat has faded owing to the extreme drought of May & June... (Smithhurst Journal, op. cit.)

July 30, 1847: ...The first of the Boats returned from York Factory, on the 22 inst. & by the 26th all have arrived.- The voyage on the whole appears to have been prosperous but the state of the water in the downward trip is described as having been very low & unless it rise very considerably before the end of August, it will we fear be difficult to get up all the supplies required from York... (Letter, Alex Christie, Fort Garry, to Sir George Simpson, Hudson Bay House, Lachine, PAM MG2 B5-2, p.85-86)

August 31, 1847: In 1847, a very dry season, it was possible to proceed with carts in a direct line near the banks of the [Roseau] river from the beginning of the marsh to the post, one mile and a half from Roseau Lake. (Hind, H.Y., 1869. Narrative of the Canadian Red River Exploring Expedition of 1857 and of the Assiniboine and Saskatchewan Exploring Expedition of 1858, vol. 1 [reprinted 1969] Greenwood Press, Publishers, New York, p. 158)

- although the May-June period was clearly very dry, this seasonal drought was balanced by normal freshet conditions when the majority of runoff typically occurs and it is concluded that overall runoff for the year was probably within the normal range.

1847-48 **- HIGH**

- dry fall, 1847

October 24, 1847: la recolte a donne tres peu...La secheresse a ete sigrande par ici autour qu'il n'a point pousse defoin... (Letter, Msg. J.N.Provencher to Bishop I. Bourget, Bishop of Montreal, dated St. Boniface, 24 October, 1847, PAM MG7 D1)

- many references to intensely cold winter
- heavy winter snowfall

March 12, 1848: I am happy to find that notwithstanding the mountains of drift in which we are entombed, all communications from the outer world is not entirely closed. Such a winter for wind, drift and turbulence...We are looking forward with hope to a more favourable season. The abundance of snow gives promise of lacking moisture. (Letter, John Bunn, Red River, to Donald Ross, Norway House, March 12, 1848, in Healey, W.J., 1923. Women of Red River. Women's Canadian Club, Winnipeg, pp. 216-219)

- high spring water levels

April 22, 1848: The water has risen very high in the river several Cattle have been swept away. At one time I saw five oxen going down the stream. The river is walled in by immense masses of ice so that it is difficult to get the Cattle out, four or five have drowned which is a heavy loss to the owners. (Journal of John Smithhurst [at the Indian Settlement], PAM MG7 B2 CMS A97)

- high water on June 1

June 1, 1848: On the fourth day [from St. Paul] Father Belcourt reached Crow Island where he joined two half-breeds on their way to Pembina...The rivers, swollen with a week's rain, were almost impassable. Red Lake River was more than eighteen feet deep at the fording place. In order to cross it they had to improvise a boat from willow branches covered with a tarpaulin in addition to a raft to carry the wagons, carts, harness and saddles. The more precious pieces of luggage were put into the boat and Father Belcourt, charged with rowing it across the swollen river, succeeded in landing on the other side a mile below the starting point. His companions undertook to guide the raft across but it was caught in the swift current and they saved themselves only by abandonning it and swimming ashore...Five more rivers had to be forded and at each one they duplicated the experience of the first. (Reardon, J.M., 1955. George Anthony Belcourt, Pioneer Church Missionary of the Northwest, 1803-1874. North Central Publishing Company, St. Paul, Minnesota, pp. 99-100)

- evidence of ice scouring of trees

late June-early July, 1848: Below the mouth of the Red Fork, we...found evidence of the power of the ice on this [Red] river during the winter season. Fifteen, eighteen, and even twenty feet above the level of the river, in July, we observed the trees on the brink of the river, either barked or deeply cut into, and even entirely cut across. (Owen, D.D., 1852. Report of a Geological Survey of Wisconsin, Iowa, and Minnesota. Lippincott, Grambo & Co., Philadelphia, Pennsylvania, p. 117)

- very dry summer

July 18, 1848: La chaleur est etouffante depuis longtemps. Il n'a pas plu. (Letter, J.N.Provencher, Eveque du Nord-Ouest, St. Boniface de la Riviere Rouge, to Msr. P.-F. Turgeon, Eveque de Sidyme a Quebec, 18 Juillet, 1848, in Lettres de Monseigneur Joseph-Norbert Provencher, Premier Eveque de Saint- Boniface, Bulletin de la Societe Historique de Saint-Boniface, Man., v. III, 1913, Imprimerie du Manitoba, Saint-Boniface, Man., p.269)

- very low water levels in August in northwestern Ontario

August 11, 1848: On each side of the river are innumerable small shallow lakes, bearing usually large quantities of rice, but the water in them had sunk so low this season that the Indians were apprehensive of a failure of the crop [Paul Kane on Lake of the Woods]. (Kane, P., Wanderings of an Artist among the Indians of North America from Canada to Vancouver's Island and Oregon, through the Hudson's Bay Territory and Back Again. Garvin, J.W. [ed.], 1925. Master-Works of Canadian Authors, v. 7, The Radisson Society of Canada, Toronto)

1848-49 **- HIGH**

- freezeup and the onset of winter were relatively early (end of October) but November cannot have been severe since the river was still reported dangerous in early December

> December 3, 1848: The continued fall of snow for the last days induced me to take the River for the Middle Ch...The snow was deep. The River was full of dangerous holes, being yet but partially frozen... (Letter, John Ballenden, Fort Garry, to A. Barclay, London, dated 29 November, 1848, HBCA A11/95 1829-1853)

- little information exists for the January-April period
- thawing conditions occurred in early April were replaced by colder weather after mid-month and a late spring (PART B)
- a normal freshet runoff is inferred because there is no mention of water levels (PART B)
- very heavy rainfall and flooding in June-August, 1849 (PART B)

1849-50 **- VERY HIGH**

- it is assumed that moisture levels in the basin were very high after the wet summer (PART B)
- mild early fall until mid-November

> November 16, 1849: The real winter set in with a pretty heavy fall of snow. The long anticipated change as usual came suddenly. Yesterday was genial & lovely-today a boisterous bitter winter. (Robert James' Journal, PAM MG7 B2 CMS A92)
>
> November 18, 1849: ...sufficient snow had fallen to enable the cariole to run. (ibid)

- information is scanty from November, 1849, to April, 1850
- although some thawing occurred in early April, spring was extremely late (PART B)
- exceptional summer flooding occurred in the summer of 1850

1850-51 **- HIGH**

- high moisture status of basin after summer flooding of 1850
- the fall of 1850 was mild until mid-November and freezeup did not occur until after November 18

> November 14, 1850: The new winter set in after a long season of beautiful weather... (Robert James' Journal, PAM MG7 B2 CMS A92)
>
> November 18, 1850: The ice is drifting down the River in large pieces denoting the intensity of the frost. It will be fast in a few days. (ibid)

- little information about winter, 1850-51
- thawing conditions began in mid-March and spring arrived very early

> March 16, 1851: A lovely day. The roads almost impassable from the rapid thaw. (ibid)

March 19, 1851: ...to my surprise I found the Plains with so little snow upon them that after wretched travelling [in the cariole] I did not reach the cottage. (ibid)

March 20, 1851: Had intended to see the Bishop today, but was well-informed of the unsafe state of the River, large openings have appeared in several places. (ibid)

- the remainder of the spring, and the very high water and flooding of the summer are described in PART B

1851-52 **- VERY HIGH**

- the antecedent conditions and the historic flood of 1852 are described in detail in PART B

1852-53 **- NORMAL**

- it can be assumed that water storage conditions in the basin were at a maximum at the beginning of the water year due to the extreme flooding of 1852
- fall conditions in 1852 were normal but not severely cold; freezeup of the Assiniboine occurred on November 11, and on November 13 for the Red

November 13, 1852: ...crossing the main river on ice...still no snow although threatening every day. (Diaries of William Cowan, PAM MG2 C15 M154)

- although light snow had fallen on numerous days, the first significant snowfall didn't occur until November 24

November 24, 1852: Mild weather...A considerable quantity of snow fell last night and is still falling this evening. Much required to make better roads. (Winnipeg Journal, HBCA B.235/a/15 1851-54)

- mild conditions persisted into early December, becoming much colder with more snow after the first week
- most of January was very mild with little snow

January 20, 1853: Splendid day, calm and mild. So little snow has yet fallen that the roads are in some places almost impracticable for sleighs. (ibid)

- rain and snow fell at the end of January and early February but total snowfall remained light throughout February

January 31, 1853: Cloudy, wind strong from the south...Some rain fell today. The ground in most places is bare of snow. An unusual thing at this late season. (ibid)

February 2, 1853: ...snow commenced after breakfast has continued nearly all day very light. (Cowan Diaries, op. cit.)

- mild thawing weather in early March removed much of what snow had fallen
- colder weather returned after March 7 with little additional snow; thawing resumed on the

17th, continuing to the end of the month and bringing on an early spring

March 20, 1853: ...thawing for some days during day rode over plains very bare. (ibid)

March 26, 1853: The winter has not been hard there has been little snow, already it has for the most part disappeared. (Letter, Msg. J.N.Provencher, Bishop of the Northwest, to Msg. I. Bourget, Bishop of Montreal, dated St. Boniface, 26 March, 1853, PAM MG7 D1)

March 29, 1853: Wind South & very fine weather the snow is now entirely off the ground. (Fort Pelly Journal Section B, HBCA)

- mild weather continued through April; the rivers began to rise early in the month and continued to rise into May

April 8, 1853: ...The river has been rising rapidly for some days... (Cowan Diaries, op. cit.)

April 12, 1853: ...The ice on the main river and also on the river Assiniboine took a start in the afternoon and drifted rapidly till nine in the evening when it stopped having jammed somewhere below. The water has risen rapidly. (Winnipeg Journal, op. cit.)

April 15, 1853: ...The ice seems to have all left the Red River last night. The ice in the Assiniboine left this evening and is running out fast. (ibid)

- there is some indication of a strong freshet on the Red and lower Assiniboine

April 7, 1853: ...The water mill at Sturgeon Creek has stopped from the back water of the Assiniboine River. (ibid)

May 9, 1853: ...river has been rising steadily since ice broke up now entering root house. (Cowan Diaries, op. cit.)

- in the upper Assiniboine region, spring water levels were low but rose in mid-May after early May snowstorms and rain

April 17, 1853: ...the Swan River is by report still fast, the water will be very very low-unless heavy rains come... (Fort Pelly Journal, op. cit.)

April 19, 1853: ...The Assiniboine River is now completely clear of ice & is very low indeed. (ibid)

May 15, 1853: ...heavy rain all day...a sudden rise in the Swan River... (ibid)

- May was very dry; virtually no rain was reported until late in the month

May 28, 1853: A thunder storm with rain in the afternoon, much wanted for the crops. Winnipeg Journal, op. cit.)

- June appears to have relatively cool and wet, particularly late in the month; from June 17 to June 30, rain was reported in the Winnipeg Journal and Cowan Diaries on 11 of the 14 days

- July and August had normal summer summer weather, with periodic rain, particularly in late August

- much rain was reported in September by Edwin Hatch at various locations between Pembina and Red Lake in the southern Red River basin and similar reports from Fort Pelly and Red River Settlement indicate the rainfall was widespread

September 16, 1853: This I think was one of the worst nights I ever passed upon the prairie in the summer. It rained until near daylight... The wind blew a perfect hurricane. (Edwin Hatch narrative in Hatch, E.A.C., 1980. Canoes routes through northern Minnesota. The Minnesota Archeologist, v. 39 (4),p. 171-176)

September 18, 1853: Soon commenced raining, and rained all night. (ibid)

September 19, 1853: ...rained all day. (ibid)

- despite the apparently light winter snowfall at the Red River Settlement and the low early spring level of the upper Assiniboine, the spring flow of the Red appeared not abnormal and rainfall was probably above-average in June, late August and September.

1853-54 **- NORMAL**

- significant snow fell in Winnipeg in October and the rivers were frozen by early in November

November 2, 1853: ...snowing a slight skim on ground much ice floating down rivers. Has been fast in Assiniboine above [?] some days ago and [people] crossing on it. (Diaries of William Cowan, PAM MG2 C15 M154)

November 4, 1853: River frozen & people crossing on foot. (Winnipeg Journal, HBCA B.235/a/15 1851-54)

- November and December were cold with snow on many days but only at Fort Pelly is there indication that it had accumulated to significant depth

January 3, 1854: A very bad day blowing a Gale with snow & drift-the snow is very deep now and will be much against our tripping. (Fort Pelly Journal, HBCA B.159/a/18 1853-54)

- most of January and February were extremely cold and at Fort Pelly, the snow was reported deep

January 18, 1854: ...very cold weather this continued cold weather is making our Cattle very poor. (ibid)

January 27, 1854: ...blowing pretty hard...the snow is too deep for oxen or Horses. (ibid)

February 6, 1854: We have never had such a cold winter as this- The oldest men say so-the thermometer was as low as 55° below zero- 8° below we have ever seen it in R.R. (Letter, William Ross, Red River Settlement, to James Ross, Toronto, PAM RFC 71)

March 6, 1854: Snow to westward very deep [toward Fort Ellice and Swan River]. (Winnipeg Journal, op. cit.)

- milder conditions began in late February, with more snow; heavy snow fell in mid-March with some thawing weather, but the weather remained generally cold with additional snow to the end of March

March 16, 1854: ...storm commenced about 8 o'clock great drifting continued till about 12. could

not see fencing from belfry gate... (Cowan Diaries, op. cit.)

March 26, 1854: Clear and still very cold...the feeling there has not been a colder day this winter-The continuance of this cold weather up to so late a date, will likely give us a very sudden thaw when it begins. (Winnipeg Journal, op. cit.)

- thawing conditions must have begun in the upper Red River basin in late March because the rivers were reported rising

March 30, 1854: ...great deal of overflowing on rivers. (Cowan Diaries, op. cit.)

March 31, 1854: Clear and cold. But, owing no doubt to there having been mild weather in the Upper Country, the water in the river is rising-the roads getting bad: on the river they must soon be impassable. We have now had a steady continuance of winter for five months. (Winnipeg Journal, op. cit.)

- a strong thaw began at the Red River Settlement in early April

April 12, 1854: Excepting the deeper drifts, all the snow now disappeared from the Plains. (ibid)

April 14, 1854: ...a good deal of water is now over the Ice of the Assiniboine River the ground is pretty clear of snow now...(Fort Pelly Journal, op. cit.)

- breakup occurred in mid-April and high water was reported in the upper Assiniboine

April 16, 1854: ...Ice commenced to drive in the Assiniboine River-water high. (ibid)

April 16, 1854: ...ice started in the main river...main river pretty clear...roads said to be bad. (Cowan Diaries, op. cit.)

April 17, 1854: ...Swan River open water very High. (Fort Pelly Journal, op. cit.)

April 17, 1854: ...ice...clearing away on main river now a little on small river. (Cowan Diaries, op. cit.)

April 20, 1854: Wind East and warm sultry weather the water still high in the Assiniboine. (Fort Pelly Journal, op. cit.)

- late April and most of May were cool with heavy rain from May 7-10 but little thereafter until mid-June
- June began warm and dry but frequent rain was reported from mid-June onward at both the Red River Settlement and the upper Assiniboine to continue to be high

June 22, 1854: ...Getting no fish...owing to the River been so high. (ibid)

- frequent rains (often heavy) continued throughout July and August at both locations and the summer appears to have been very wet; between July 1 and August 24, rain was reported at Fort Pelly on 22 of the 55 days

July 11, 1854: the road is very swampy, the late rains having increased its naturally bad state [Hillyer going west from Portage La Prairie]. (Journal of Rev. Charles Hillyer, PAM MG7 B2 CMS A88)

- rain was also reported on about 1/4 of the days in September at the Red River Settlement

1854-55 **- NORMAL**

- October, 1854, was mild and relatively dry; freezeup occurred on November 11

November 11, 1854: ...last night the river took tho' yesterday it was open from side to side there was also a heavy fall of snow. (Journal of Abraham Cowley, PAM MG7 B2 CMS A86)

- very little snow fell in November and December

December: There was grief in the Red River Settlement that Fall too. The weather was damp and foggy, with no snow...Arctic winds came in November but still there was no snow. A prairie fire swept over the haylands from Fort Garry to the Stone Fort...But snow didn't even come in December and the last day of the year witnessed another prairie fire. (Knox, Olive, 1958. John Black of Old Kildonan. The Ryerson Press, Toronto, p. 94-95)

- snow fell in two storms in mid-January but little further snow was reported until mid-March

January 11, 1855: ...A heavy snow had fallen [at the Red River Settlement]. (ibid, p. 96)

January 16, 1855: The snow had deepened greatly within a few hours & the journey was heavy. (Cowley Journal, op. cit.)

March 14, 1855: ... the roads heavy from snow. (Diaries of Dr. William Cowan, PAM MG7 C15 M154)

- thawing began at the end of March and continued through to breakup in mid-April

April 18, 1855: ...ice running in main river. (ibid)

April 19, 1855: ...main river clear...ice running in Assiniboine for some time. (ibid)

- no information on water levels was included among numerous obervations of the breakup process and it is assumed that they were within the normal range
- May was warm with periodic rain; June, July and August were warm and exceptional rainfall was reported by Donald Gunn

June: Three inches of rain fell on the 17th, one on the 19th and six on the 25th [for a total of 10 inches]. (Donald Gunn's Record at Lower Settlement, quoted in Dawson, S.J., 1859. Report on the Exploration of the Country between Lake Superior and the Red River Settlement, reprinted 1968, Greenwood Press Publishers, N.Y.)

July: ...7th rain 3 3/8 inches, 10th, rain 3/4 inches. Thunderstorm on the 17th, rain 3 inches, 26th, 1 inch rain; 29th, 3 inches rain; 30th, 2 inches; total 14 5/8 inches... (ibid)

August: ...On the 8th, 5 inches of rain fell; 11th, 5 1/4 inches fell, 14th, 2 inches; 27th, 1/4 inch; total 12 ½ inches. (ibid)

September: ... Total of rain during the month, 6 ½ inches... (ibid)

- from the Dawson report, then, total precipitation from June to September was 43 5/8 inches. According to the United States Patent Office (1861) precipitation, recorded by Gunn during this period was 39 3/4 inches. Whichever of these measurements is correct, the figures seem unreasonable but as was noted in PART A heavy rainfall was also recorded at Lac qui Parle in southern Minnesota in this summer; even if the total is

discounted due to measurement technique, it seems certain that rainfall during the summer was, at least, above-average

1855-56 **- NORMAL**

- October and November appear to have had normal temperatures and precipitation; the river froze on November 12

- late December and early January were extremely cold

January 9, 1856: The winter has hitherto been one of the severest on record-Frozen noses, faces are the order of the day. Thermometer sometimes as low as -50 & 51 and this extreme cold has continued for 5 weeks or so -today is milder... (Letter, Rev. John Black, Red River, to James Ross, Toronto, PAM RFC 158)

- the last half of January and most of February were much milder
- cold and mild weather alternated through March and much of the snow had melted by the end of the month
- April was generally mild with some snow and rain; breakup occurred at a normal time (April 16-20)

April, 1856: ...On the 16th the river began to throw off its winter coat; clear of ice on the 20th... (Donald Gunn's Record at Lower Settlement, quoted in Dawson, S.J., 1859. Report on the Exploration of the Country between Lake Superior and the Red River Settlement, reprinted 1968, Greenwood Press Publishers, N.Y.)

- May was warm with sufficient rain at Fort Pelly to maintain high water in the upper Assiniboine

May 26, 1856: ...no fish from the Barrier owing to the high water. (Fort Pelly Journal, Sect. B (copy) 1855-57 mfm 475)

- Fort Pelly reported frequent rains and high water in the upper Assiniboine in June and runoff in the vicinity of the Red River Settlement seems also to have been high

June 11, 1856: ...Raining all day...I am much afraid this is going to be a wet Summer. (ibid)

June 12, 1856: ...The Rivers are very high owing to this continual Rain. (ibid)

June 30, 1856: ...the unusual quantity of water which poured into every stream [last year, 1856] caused serious injury to many of the bridges... (Minutes of the Council of Assiniboia, June 25, 1857, in Oliver, E.H., 1914. The Canadian North-West: Its Early Development and Legislative Records. Publications of the Canadian Archives, No. 9, Government Printing Bureau, Ottawa, p. 423)

- very little rain was reported at Fort Pelly in July but apparently more fell at the Red River Settlement

August 7, 1856: We have had very heavy rains lately and exceedingly hot weather. The heat was almost insufferable for some days. (Letter, Henrietta Black, Kildonan Manse, to James Ross, Toronto, PAM RFC 189)

The month of July...was extremely wet. Our hay ground in the parks, and everywhere else, was

drowned. The month of Augt. has been dry... (Letter, Henrietta Black, Kildonan Manse, to James Ross, Toronto, PAM RFC 189)

- Fort Pelly reported rain on 1/3 of the days in September

1856-57 **- HIGH**

- fall and winter conditions in 1856-57 leading to heavy late winter snowpack are described in PART B
- spring was remarkably late, with river breakup not occurring until after May 9 (PART B)
- spring water levels were very high with apparent flooding, at Pembina at least, and high water levels persisted into the summer (PART B)

1857-58 **- LOW**

- the fall of 1857 was relatively mild and dry until November 7 when 4 inches of snow fell; the Red River froze over on November 9 but few very cold days and little snow were reported by Dawson by the end of January (Dawson, S.J., 1859. Report on the Exploration of the Country between Lake Superior and the Red River Settlement, reprinted 1968, Greenwood Press Publishers, N.Y.)
- February was colder but still with no major snowfalls
- mild temperatures prevailed in the last week of February and throughout March, and spring began early

March 23, 1858: The season is particularly mild & the general thaw seems to have commenced. The ice is strong but there is much water along the shore & it is unpleasant getting on it. (Journal of Abraham Cowley, PAM MG7 B2 CMS A86)

March 28, 1858: [The small congregation] is of course owing to the state of the River partly covered with the winter ice & partly open... (ibid)

March, 1858: The winter was mild throughout, except about the middle of February, when...the thermometer indicated -37° Fah., but only on one occasion. The greatest average depth of snow did not exceed one foot, while in the wooded region, to the eastward near Lake of the Woods, it might be about 1 foot 4 inches. (Dawson, op. cit.)

March 31, 1858: The spring has set in earlier than usual. The snow is mostly gone- the creeks are all running and the ice on the River has started here today-what it was never known to do in March before-Last year it was the 2nd of May, '56 16th April. (Letter, Rev. John Black, Frog Plain, to James Ross, Toronto, PAM RFC 228)

April 1, 1868: Robert Tate [and]...William Slater...had started from Red River on the 11th of March and accomplished their journey during the severest time of the whole year. In the first place the snow had melted off unusually early, they had to throw away their snow shoes and walk through half-frozen slush from morning till night; the ice had broken up on the river shortly afterwards, and they had to wade many of them. (Spry, I.M., 1968. The Papers of the Palliser Expedition, 1857-1860. The Champlain Society, Toronto, p. 169)

- apart from two snowstorms on April 5 and 17, very little precipitation was reported and as early as April 8, the river was falling
- snow fell in mid-May and showery rain was reported on several days in late May
- from June through August, rain (with intensities varying from light to continuous or heavy) was reported in Winnipeg with regularity; various journals in the Settlement indicate rain on 30 of the 101 days from May 18 to August 26 and on 4 of the first 6 days of September; at Fort Ellice in Saskatchewan, rain was reported in 21 days in June and July.
- this apparently adequate rainfall over a broad region either was unrepresentative of conditions to the south and east, or was not sufficient to overcome the light winter snowfall since low water was widely reported throughout the summer

> May, 1858: As the water was very low at the time we passed along, it was confined to a channel from two to four chains in width for a distance of 6 miles meandering through a valley which in times of high water is covered... (Dickinson, in Dawson, op. cit.)

> June 1, 1858: ...in consequence of the very low state of the water this year, numerous small rapids were formed in rivers connecting Gun Flint Lake with Lake Seiganagah. In ordinary seasons these rapids are passed without difficulty, but this year they involved the portage of a portion of the baggage and the letting of the canoes down them by rope...Our guide preferred going by Loon's Narrows, fearing that the always dangerous Namenkam Rapids would be almost impassable for heavily laden canoes on account of the low stage of the water. (Hind, in Dawson, op. cit.)

> August, 1858: The waters on the rivers and lakes on the east side of the height of Land, the Lake Superior water-shed, were high in 1858, while those on the west side, or the tributaries to Lake Winnipeg were unprecedently low. In many of the lakes recent water marks, four and five feet above the present level, were frequently observed, The remarkable lowness of the water was attributed by the half-breeds and Indians to the very small quantity of snow which fell on the western slope during the last winter. (Hind, H.Y., 1869. Narrative of the Canadian Red River Exploring Expedition of 1857 and of the Assiniboine and Saskatchewan Exploring Expedition of 1858, vol. 1, reprinted 1969, Greenwood Press, Publishers, N.Y., p. 75-76)

> October, 1858: This part of the country [Pembina Mountain] is quite destitute of water; there are no creeks, and the ponds which are said to be generally full of water were now quite dry... (Hind, in Dawson, op. cit.)

1858-59 **- HIGH**

- the fall of 1858 seems to have been normal in terms of temperature and precipitation; the freezeup date of November 12 was not unusual

> November 12, 1858: Red River crossed on foot. (Winnipeg Journal, HBCA B.235/a/16 1858-60)

- cold weather began in early November and remained very cold until mid-January, with snow reported on 16 days (about 1 in 4)
- from mid-January to the end of February, severe cold weather alternated with mild, and periodic snow fell
- March was generally very mild, on occasion thawing, from early in the month until cold weather returned on the 24th, lasting until April 10; heavy snow was reported in two storms
- spring was very late

April, 1859: ...16th...a clear day drifting all day-- and plenty of snow in the woods and very winter like...no water to be seen standing on the ice yet I walked on the ice on the river from the stone fort to Mr. D. Gunn's, on ... 19th April...the next day no water to be seen on the river...and quite winterlike and cold...[24th] not thawing much; plenty of snow still, no water on the ice in the river yet...[26th] a great quantity of snow thawed away...27th...the river covered with water---no water had been seen the day before on the ice... (Diaries of Samuel Taylor at Red River Settlement, PAM MG2 C13)

- breakup did not occur until May

...people walked on the ice from G. Kiplins to Thomas Fiddlers on ...2nd May, and it all broke there a.m. 3rd May verry fine warm weather came all at once and the ground dried up in 3 or 4 days... (ibid)

- the Red River continued rising from breakup until May 16

May 14, 1859: ...the River continues rising. (Winnipeg Journal, HBCA B.235/a/16 1858/60)

May 16, 1859: ...the River has fallen a very little (ibid)

- very high waters and severe flooding were reported throughout Minnesota and the upper Mississippi basin by the Earl of Southesk travelling from St. Paul to Red River; several of the streams he mentions are tributaries of the Red

May 12, 1859: The whole country [along the upper Mississippi] is now much flooded, the water being higher than has been known since (I think) 1826. Sir George [Simpson] doubts if we shall be able to get on beyond St. Paul,-it will be a wet ride at all events. The Mississippi was in high flood, submerging most of the willows that grow on its banks... (The Earl of Southesk, 1875. Saskatchewan and the Rocky Mountains. James Campbell and Sons, Toronto, p.7)

May 14, 1859: [Mr. James McKay from Red River] was reassuring: he had found the country everywhere passable, the roads in good order, and the swamps tolerably free from water, though the rivers were unusually swollen [Southesk at St. Paul]. (ibid, p. 8)

May 20, 1859: M'Kay decided to halt ...[at] an excellent campling place...near which flowed with calm but powerful sweep the broad and swollen stream of the Crow-wing River. (ibid, p. 15)

May 25, 1859: ...[We rode twenty miles]...only stopping when we reached the flooded stream of the Rice River...Every brook was a river, every swamp a lake, the road a swamp. (ibid, p. 22-23)

May 26, 1859: This deep wide stream [Red Lake River] rolled on in a heavy flood a few yards below the willows that sheltered our tents, and as I watched its swift and turbid current, I could not but wish that everything were safe across. (ibid, p.24)

May 31, 1859: ...the only incident of the day was the passage of the Vieux Marais, a horribly swampy creek, which from its depth offered a serious obstacle, although only a few yards wide...I was quite...well placed on Toma's powerful back, though even he had enough to do in wading this deep and treacherous morass. (ibid, p. 28)

- rain was reported on four days in the first week of June

June 1, 1859: We had a heavy rain and thunder at night...It cleared up for a few minutes between 4 and 5 A.M., so we set out on our march; rain however, came on again, and lasted nearly four hours [nearing Fort Garry]. (ibid, p.29)

- heavy rain was reported in the Winnipeg Journal on six days in July, little rain was reported in August, and several heavy rainstorms occurred in September

- although the Red isn't mentioned specifically after the freshet, it is apparent from the Earl of Southesk's account of high waters in tributaries such as Red Lake River that it would have felt the effects of the high runoff in Minnesota. This, combined with the late breakup and heavy late-winter snowpack, would probably have produced a high runoff in the Red, although clearly not of a threatening nature.

1859-60 **- NORMAL**

- October, 1859, was generally described in the Winnipeg Journal as cold with little snow; freezeup was relatively early

November 4, 1859: The river was frozen over on the night of the 4th of November (Winnipeg Journal, HBCA B.235/a/16 1858/60)

November 6, 1859: ...the ice took in the Assiniboine & the main River is also frozen across at the Point. (ibid)

- milder weather with considerable snow followed after the first week of November but turned very cold in the last week, generally continuing until mid-January when it again became unusually mild until the end of the month
- severe cold returned at the end of January but in February the weather alternated between very cold and very mild, with snow reported on six days

January 31, 1860: ...while camping near Snake River [south of Pembina], we heard trees cracking repeatedly from the intenseness of the frost...The reports were loud and sharp, I was informed, actually splitting into visible rents and fissures. (The Earl of Southesk, 1875. Saskatchewan and The Rocky Mountains. James Campbell and Son, Toronto, p.367)

February 14, 1860: The winter, of which the longest and most severe portion has now passed, has been remarkable for its changeableness of temperature... (Nor'Wester Newspaper, Feb. 14, 1860)

- spring began early with strong thaw, rapid snowmelt and rising river levels by mid-March

March 15, 1860: Thawing very much wind S. (Winnipeg Journal, op. cit.)

March 18, 1860: Wind S & NW the ground bare of snow everywhere & the water rising in the River. (ibid)

- low April water conditions in the Red are described in PART B

- wet summer and high water in the southern Red River basin (PART B)

- water levels were clearly low during the freshet but appear to have been reasonably high for a long period from June onward, sufficiently so that the steamboat was able to make a final trip on August 30, which was not always possible even in normal years

1860-61 **- VERY HIGH**

- this water year included the third highest historic flood (PART B)

1861-62 **- LOW**

- although water levels were described as low at the end of September, 1861, they must have been actually quite favourable since the steamboat was expected to be able to make a final trip at this unusually late date

> October 1, 1861: It is expected that the boat will be able to make another trip before being laid up for the year. We are agreeably surprised to find she has made so many. The water is now very low and yet she runs! (Nor'Wester Newspaper, October 1, 1861)

> November 11, 1861: That the season was reasonably satisfactory is shown by an item in the St. Cloud Democrat of December 5th, 1861, which stated that Mr. E.R.Abell, engineer of the Pioneer...reported that the boat had been laid up about 30 miles below Fort Garry on November 1st, and that there had been a good stage of water during the entire season. (Bill, F.A., 1847. Life on the Red River of the North, 1857 to 1887. Wirth Brothers, Baltimore, Md., p. 57)

- October was mild without much rain

> October 31, 1861: ...this is the finest fall that any person remembers. (Diaries of Samuel Taylor at Red River Settlement, PAM MG2 C13)

- the river froze on November 11 but November and December remained unusually mild with little snow

> November, 1861: ...the River set fast on...11th...17th a fine day verry little snow yet...[15th] they found all the swamps in the woods full of water... (ibid)

> December 24, 1861: The winter thus far has been remarkably fine. (Nor'Wester)

> December, 1861: ...11th fine weather all this time and verry little snow yet...[20th] There has been hardly any snow since about the 20th of the last month; some people have not gone off to fish yet for want of snow... (Taylor Diaries, op. cit.)

- winter arrived with severity at the beginning of January and continued cold (with brief mild periods) through February
- snowfall appears to have been light at the Red River Settlement, somewhat heavier at Fort Pelly; strong thawing began in mid-March

> March, 1862: ...6th was the first mild soft day we had yet this winter...15th pretty soft, and water about the doors...23rd a fine warm day some parts [of] the roads are getting bad now, and the fields are getting bare...24th it was snowing thick a.m. and blowing hard but after dinner it fell a small rain...29th the snow is melting now...fast... (ibid)

> April 2, 1862: Spring is opening upon us in right earnest. The weather is delightfully genial. The snow is off the ice for the most part, and the creeks are beginning to run. Carolling by land is at an end, and will soon cease upon the ice, too. (Nor'Wester, op.cit.)

- April turned colder with snow, and breakup was quite late

April, 1862: ...4th snowing thick as we came home the snow was deep out there then...15th the snows soft in the woods now...it began to snow thick...18th...the River is still verry strong yet, and people still driving up and down the same as winter...I walked across the river on a horse on [the] 28th...29th...the River began to break up opposite the school and downwards...30th the water rose over Thomas Fidlers bank when the River broke, but it soon fell, fine dry weather about this time and farming everywhere. (Taylor Diaries, op. cit.)

May 2, 1862: The ice is now leaving the river here. (Journal of Abraham Cowley, PAM MG7 B2 CMS A87)

- from late April through the entire summer, although rain did occur, drought was the major concern expressed

May, 1862: ...11th verry hot the ground is now verry dry but today...some fine showers of rain...25th verry warm thunder and a little rain after dinnertime, rain now is much needed...29th hardly any rain to be seen now the weather is dry and warm now. (Taylor Diaries, op. cit.)

June, 1862: ...19th...it is remarkably dry ever since the river opened and hot, hot... (ibid)

July 9, 1862: ...the crop will not be a heavy one. This is owing to want of rain in the early stages of growth. Within the last month, there has been quite enough, but the month before when it was so much required there was not a single shower...(Nor'Wester, op.cit.)

- by late July, the water level in the Red was too low for steamboat travel

July 23, 1862: ...the low water kept her [the International] two days and a half at Goose Rapids...On the last trip, they came over the rapids with 8 inches less water than Capt. Bryant had last August when he was stuck fast for four days. (ibid)

September 11, 1862: We cannot be far astray...in supposing that [the steamboat] must be detained by the lowness of the river...(ibid)

- from the accounts of Samuel Taylor and The Nor'Wester, rain fell more frequently in June, July and August than these extracts would suggest; the dryness of the summer, however, is clear and this combined with the light late-winter snowpack would suggest that runoff would have been low for the water year

1862-63 **- LOW**

- October, 1862, was cold with an early freezeup and heavy snow on the 23rd

October, 1862: Of late, the weather has become quite cold. The river froze over on the 18th October but afterwards broke up and again set fast on the 31st. Snow first fell on the 23rd October, and that fall had almost disappeared when a second fall on the 30th seems to have ushered in a permanent coating. (Nor'Wester Newspaper)

- much of this snowcover was removed by warm weather in mid-November and mild weather continued through December and January with little snow in December and some in the latter half of January

December, 1862: 2nd verry little snow yet...19th...hardly any snow bad hauling...28th a fine mild dark day still little snow...30th...clear weather every day now and warm. (Diaries of Samuel Taylor at Red River Settlement, PAM MG2 C13)

January, 1863: ...16th snowing from south...17th a mild snowey day...20th a mild day...22nd clear and warm...25th a clear mild day. (ibid)

- February began very cold but became mild by mid-month and snowfall must have been somewhat greater since on the 15th, Taylor commented "the snow is pretty deep now:.
- with brief exceptions, March was mild throughout, continuing into April

March, 1863: ...1st a clear pretty warm calm day...7th a snowey mild day...15th verry soft...16th a mild day...[19th] warm weather...roads bad...29th blowing strongly from south (ibid)

April 13, 1863: Spring has fairly set in.. The weather has been very fine and mild. The snow has almost entirely disappeared...The very limited quantity of snow that fell during the past winter has had something to do with this as well as with the moderate flow of our creeks and rivulets. The ice will probably break up in the course of the present week. (Nor'Wester, op.cit.)

- breakup occurred on April 15-17; little precipitation was reported for the month and concerns were expressed about the lowness of the river

April 27, 1863: Our readers will recollect what trouble the International had last summer [1862] with the low water. It is to be feared there will be still greater embarrassment this year for the river is extremely low just now...On Wednesday the 15th instant, the river-ice broke up and began to drift down current. On the 18th and 19th we had very bad weather- snow and sleet with a heavy north-easterly wind...It is feared that the season will be a very dry one. The river has been unusually low for the season and the creeks are almost dry. (ibid)

- May was warm and very dry
- although some rain was reported at the end of May and 1st of June, dry hot weather continued through June and July, and the water level of the Red was too low for the steamboat

June 2, 1863: At length we have had rain. Since last Thursday there have been several refreshing showers...Having had over five weeks of dry weather, this rain is much needed. (ibid)

June, 1863: 1st was a fine rainy day the ground is still dry...30th dry, the weather was never seen people says so long without rain, it thunders often and yet no rain, sometimes it is verry hot, it gets verry rainy like sometimes but it clears off and there is no rain. (Taylor Diaries, op. cit.)

June 30, 1863: Add to [the Indian troubles] the troubles of extreme low water and the last of June found the International "safely" moored [at] ...Abercrombie. (Bill, F.A., 1847. Life on the Red River of the North, 1857 to 1887. Wirth Brothers, Baltimore, Maryland, p. 63)

July 8, 1863: The want of rain is becoming a serious matter with farmers. The season thus far has been a very dry one and cereal crops look parched. On Saturday last the thermometer registered 101° in the shade. (Nor'Wester, op.cit.)

July, 1863: 1st...this is the dryest summer that any one can remember...17th...low water in the river. (Taylor Diaries, op. cit.)

- some rain fell in August but the month was also generally dry; more regular rain fell in September but low waters continued

September, 1863: ...[boats from Norway House] came up the river upon the 7th, they could not proceed for want of water...[after the 19th] the Watermills are all dry and will not be able to grind this fall...(ibid)

1863-64 **- VERY LOW**

- October, 1863 was cold and snowy with an early freezeup

October, 1863: A great fall of snow a.m....3rd-- and snow again a.m. 4th...18th it was wet snow falling all day...19th soft wet snow falling...20th a wild snowey day...the River frozen over a.m. 22nd...24th plenty snow now...25th plenty snow on the ground...Stevens and myself went across the River through a track cut through the ice opposite...Fidler's. (Diaries of Samuel Taylor at Red River Settlement, PAM MG2 C13)

- November and early December were milder and some of the snowpack was removed
- from mid-December to March, cold and mild periods alternated and in late February, thawing conditions began

February, 1864: ...22nd clear and verry warm snow melting fast...24th a rainy fore part of the day and a wet snow from East in the evening...25th a real soft day... (ibid)

March 5, 1864: The snow is disappearing and we expect an early spring. (Journal of Abraham Cowley, PAM MG7 B2 CMS A87)

March, 1864: ...25th there is very little snow wasted here yet the roads down here are as good as any time in the winter, but up this settlement the snow is almost done... (Taylor Diary, op. cit.)

- thawing proceeded more gradually in April and river breakup didn't occur until late April

April 12, 1864: The transforming process has been an unusually gradual one this year. We have had fine warm, sunny days and then again the icy breath of winter has chilled us by a cold, north wind...Here and there the cattle feed on small patches of the prairie where the snow has melted off. At the Long Lake, we believe, the cattle have been at large on the plains for weeks past... (Nor' Wester Newspaper)

April 26, 1864: Early this week the ice commenced to break up and float lakewards in a compact body, which in a few days became broken up into innumerable fragments. The river is higher than anticipated though the rise of water has not been so sudden or so great as in previous seasons... (ibid)

- low water was reported in the upper Assiniboine region

April 27, 1864: ...from the shoal state of the water in the Swan River no pieces can be taken in boats all the way to the Store... (Fort Ellice Journal, HBCA B.63/a/7 1863/64)

- cool dry weather and low water were reported in May and although some rain was reported in June, dry weather caused concern for the crops and water levels; extreme drought persisted for most of the summer

May, 1864: ...this spring the Watermills cannot grind for want of water...20th; a hot day, the weather is dry dry now, verry rare to find any water in any swamp now, this is so far gone of the third- dry summer...The steam boat made one trip about two weeks ago--but she will not run more for want of water if no rains come... (Taylor Diaries, op. cit.)

June 21, 1864: The crops. Where are they? Burning, drying, withering in the ground! ten days more of this increasing 'Drought' and the question is dismally put at rest. We shall have none... Since the above was in type, we were thankfull to say, a fine rain has fallen over the Settlement. (Nor' Wester Newspaper)

July 23, 1864: All through the Sauk Valley and Northern Minnesota generally, the season has been unusually dry... (ibid)

August 18, 1864: The oldest inhabitant does not remember a summer of such extraordinary long-continued heat as we have experienced this year in Assiniboia...That this is the case will readily be believed when we say that the thermometers have indicated from 87 to 90, 97, and even 100 degrees in the shade! Within the past 40 or 50 years, such a summer of heat and wind has never been known in Rupert's land. When the sky became overcast with clouds, in most cases the grateful rain was carried beyond us by high winds and the land remained parched...Despite some smart showers in June and July, there is barely enough herbage on the plains to feed the cattle. (ibid)

August, 1864: The heat of the summer of 1864 at Red River was so extreme that nobody in the settlement remembered such another. The thermometer sometimes continued for a considerable portion of the afternoon to stand at 100 degrees in the shade. The river sank and the International made only one trip...The droughts prevailed until the middle of July, when rain for the first time visited the parched ground. With it, unfortunately, arrived swarms of locusts... (Hargrave, J.J., 1871. Red River. Reprinted 1977, Friesen Printers, Altona, Manitoba.)

1864-65 **- NORMAL**

- October, 1864, was mild and relatively dry but cold weather began in early November

November 2, 1864: It is the commencement of November, but we are yet experiencing our Fall season. ...The days are sunny and gloomy by turns-the latter being decidely the preponderance, and there being every appearance of a good downfall of rain or snow, which, however, does not come in any considerable quantity...Last year winter had unmistakably commenced ere this. (Nor' Wester Newspaper)

November 12, 1864: The River is now frozen over- on the 8th there was ice upon the water-on the 9th we had to break our way through it-but on the 10th we all walked over the river on ice. (Journal of Abraham Cowley, PAM MG7 B2 CMS A87)

- 5-6 inches of snow fell in mid-November but mild weather and rain removed it by the end of the month

November 28, 1864: We had such mild weather towards the close of last week that the snow has all but disappeared off the roads and sleighing is abandonned. There was a heavy fall of rain yesterday evening which, followed by the hard frost of last night has sheathed the roads in ice. (Nor' Wester Newspaper)

- December and early January were generally cold and dry, with milder weather and considerable snow after January 7 until the end of February

January, 1865: [7th] pretty mild day...[13th and 14th] fine weather... 22nd...rather cold north wind the snow is pretty deep in the woods now...30th was a pretty warm day. (Diaries of Samuel Taylor at Red River Settlement, PAM MG2 C13)

February, 1865: 2nd a mild soft rather rainy day...20th...snowing thick... (ibid)

- March was cold with much snow until the 14th when thawing began and continued to the end of the month

March, 1865: 1st a snowey day and drifting...2nd Snowing and drifting all day...11th...there was a lot of snow fell a.m....the first little mild weather we have had began on the 14th...17th and 18th mild weather now...25th a soft day roads bad, there was a fall of snow in the night...27th was a wet snow falling thick...29th the snow was all off in some places, and in some places it was deep... (ibid)

- mild and colder weather alternated through April, delaying complete breakup until after the 22nd; considerable rain fell early in the month and very heavy snow fell on the 6th

April, 1865: ...it began to rain about 11 o'clock a.m. on the 3rd and rained heavy all night and next day... 6th the worst day we had the whole winter for snow and drift, and a regular storm of wind...sometimes I could not see the woods at each side of the Road...the ice began to break at the Stone fort on ...the 22nd...the 23rd down below Mr. Bunn's house at Victoria Cottage... (ibid)

April 17, 1865: The snow storm on the 6th is believed to have been the most severe occurring here for 20 years. There was a perfect hurricane for twenty-four hours, and the snow flew in clouds, so that it was impossible to see twenty yards in any direction out-doors. Both before and since this storm, the weather has been mild and spring-like. (Nor' Wester Newspaper)

- in contrast to the 3 previous years, the freshet appears to have been strong

April 17, 1865: The mail carrier states that a freshet had occurred at Pembina the water rising four feet so suddenly that the people there could not save their fishing nets. Considerable freshets has also occurred along the Mississippi, sweeping away the telegraph poles and wire at some points and doing other damage. (ibid)

May 13, 1865: Plenty of water is reported [by the steamboat company] all along [the Red River]-there being on the most dangerous bar (the Goose Rapids) some eight feet of it. (ibid)

- May was hot and dry but heavy rain fell throughout June

June 8, 1865: Vegetation never looked better than it has since the heavy late rains...(ibid)

June, 1865: 1st it began to rain after dinner, but in the evening it began to Thunder and there was the heaviest fall of rain that has been for three or four years back...16th a warm rainy day...18th showers now and then...there was a great deal of rain this week...24th a rainy day...25th a dark cloudy rainy like day the ground wet... (Taylor Diary, op. cit.)

- July and August appear to have been dry since little is reported in the Taylor Diaries for these months
- considerable rain fell at Fort Ellice in the first part of September, causing a rise in the Qu'Appelle River

September 16, 1865: ...[The river] is very high owing to the late heavy rains. (Fort Ellice Journal, HBCA B.63/a/9 1865/67)

September 17, 1865: ...The River still rising. (ibid)

1865-66 **- NORMAL**

- cold weather set in late in October, 1865, and froze the river but milder weather removed it by mid-November and it did not refreeze again until late November

October, 1865: ...some parts of the river frozen over the night of the 26th but opened in the daytime...29th...all the River is covered over with ice down here this two or three days back...31st--the fishermen cannot get into the river for ice, it is now strong, the weather is cold now... (Diaries of Samuel Taylor at Red River Settlement, PAM MG2 C13)

November, 1865: ...6th and all the week has been what we might call the Indian summer...[11th and 12th] the ice broke up and the River cleared out there was not one particle to be seen...[15th-18th] fine weather not cold, south wind the ground was thawed and soft as it was in summer...19th raining...20th it cleared up and was warm and the whole week has been clear and warm...2nd there is not a spoonful of snow yet...on the morning of the 28th there was nearly three inches of snow on the ground the River was nearly all fast a.m. 28th but some men did come over with a skiff, from the other side every morning until the 30th a.m. (Taylor Diaries, op.cit.)

- December and January weather appears to have been normal but not severely cold
- total snowfall remained light until February

February, 1866: ...3rd a verry cold day...a good road, the snow is not deep at all yet...6th and 7th rather cold; a great fall of snow on the 8th...[16th] there is now a good quantity of snow on the ground...the last days of the month melted the snow away verry much. (ibid)

- more snow fell in March and the snow cover was reported deep

March, 1866: 1st...it began to snow before bedtime, and it snowed and drifted most of three days, the snow is deep now...15th ...the weather is still keeping cold the snow is deep...[24th] the weather is still cold, we have had no warm days yet...25th...not verry cold, snow deep deep now...27th the Weather began to be a little warm, and the following days there was some water on the Public Road... (ibid)

- thawing began slowly in April but became stronger by mid-month; breakup did not occur until early May

April, 1866: 3rd...the weather is still cold not thawing much yet...6th...the snow is deep in the woods...13th and also the 14th began to thaw the snow pretty fast...17th rain most part of the day making plenty water pretty warm weather...20th a great fall of wet snow...21st...plenty water on the roads...some of the ice began to break at the Fort a little only on...28th... (ibid)

May, 1866: 1st a fine farming day there was about one quarter of a mile of open water from a little above the fort gate down to below J. Clouston's water mill upon the 2nd p.m. then the ice all cleared out on the 3rd it cleared out at lower sugar point on...4th... (ibid)

- high water was reported in the Qu'Appelle River

April 23, 1866: The river all most clear of ice. Mr. Watt...arrived at the Qu'Appelle river but was [?] on account of the highth of the River. (Fort Ellice Journal, HBCA B.63/a/9 1865/67)

May 17, 1866: ...they left [3 carts] on the other side of the Qu'Appelle the water being too high to get them across. (ibid)

- June was wet in the Red River Settlement and much rain and snow fell at Fort Ellice

June, 1866: ...2nd there was thunder but little or no rain, we need rain much now...4th heavy rain...heavy rain 5th rain and thunder on the 6th and 7th...9 a.m. the ground covered over with snow, and snowing thick now and again during the day, and a cold north wind all day...20th p.m. terrible thunder and bright lightning and heavy rain...p.m. the 23rd some big hail fell amongst the rain... (Taylor Diaries, op. cit.)

June, 1866: [8th] Singular weather for the time of year. Raining hard all morning which turned to Snow about noon & continued till the present time. Very cold wind from North...Snowed all after noon...[9th] Snowed all night and till About 8 A.M. this morning...[10th] Raining torrents all day...[11th] We have had very rainy weather of late...[16] Almost the first fine day during the present month...[23rd] Heavy rain...[25th]...the frequent rains rendering the roads impassable for heavily loaded vehicles. (Fort Ellice Journal, op. cit.)

- little rain was reported by Taylor in July but August and September seem to have had normal amounts

1866-67 **- NORMAL**

- the latter half of October was cold and the rivers were frozen by the end of the month

October, 1866: ...27th...the boys are skating on the little lake below our house some days ago;-- a great fall of snow on the morning of the 29th...[30th] cold in the morning and the ground covered with snow all the river frozen over a.m. (Diaries of Samuel Taylor at Red River Settlement, PAM MG2 C13)

- milder weather and rain opened the river again and it didn't refreeze until November 18

November, 1866: 1st a calm snowey day rather cold...The River set fast enough on the first...4th plenty of people came to church from the other side of the river by walking and the ice was strong...7th was calm and warm...the ice all broke up and cleared out on the 7th--there was a good deal of rain on the 7th...there was a great fall of snow after breakfast the 8th and the ground verry wet...the 10th the ground was frozen pretty hard...ice floating here and there in the River 11th...12th a fine day river open..18th...the River is all fast now again but weak... (ibid)

- December was quite mild with abundant snow and rain and continuously cold weather didn't begin until mid-January

December, 1866: 1st a pretty day hardly any snow...2nd...rain at dinnertime...[5th] a really warm day snow wet indeed most of the ground is bare, people cannot haul yet...11th was clear and cold, there is so little snow yet that the roads are slippery...17th pretty mild and snowing...[18th] a course snowy day...20th snowing thick...there was a heavy rain a.m. the 22nd and then after breakfast it snowed thick...several people heard thunder on the 22nd before it began to rain hard... (ibid)

- February alternated between cold and mild with "a good deal of snow" on the 22nd (Taylor Diary, op. cit.)

- little snow was reported in March, which had generally cold temperatures until the last week when thawing began. April was sufficiently cool to delay breakup until late in the month

March, 1867: 1st a cold snowey day...4th cold a.m. indeed the whole week was cold...24th...we have had no warm weather yet...25th a pretty day the weather a little soft...28th a fine soft day warm... (ibid)

April, 1867: ...12th the snow is nearly all off now the ice in the River is getting bad now...23rd snowing...there was a piece of open water opposite John Clouston's Mill since the 19th the ice began to move down p.m. 26th a little, but, the 27th it cleared down to the point at Mr. Murray's a cold day... (ibid)

- early May was cool and wet, becoming warm after the first week

May, 1867: ...Rain and snow 3rd snow the 4th...the ground was covered with snow a.m. 5th. We have not been ploughing yet, the ground is wet 13th then we had a fine shower of rain...14th rain the whole day... (ibid)

- little information exists for the summer; Traill at Fort Qu'Appelle reported an apparently significant flood (PART B) but there is no independent confirmation of high water and it seems that either Traill was mistaken about the year or was misinformed (PART B)

1867-68 **- NORMAL**

- October, 1867, was cold, with snow; the rivers were reported fast on October 31 (Diaries of Dr. William Cowan, PAM MG7 C15 M154) but were opened a week later by mild weather which remained until the end of the month

- from scarce information, December and January seem to have been cold and snowy

January 6, 1868: We are almost buried in snow... (Letter to the Nor' Wester Newspaper from Pembina)

January 19, 1868: All the sleighs are now in from Abercrombie, the unusual depth of snow has however compelled many to leave whole or parts of loads on the way down. (Nor' Wester Newspaper)

- Cowan reported alternating cold and mild weather through February and March, with little mention of snowfall
- by late March, a strong thaw began

March 29, 1868: ...plain road very bare, down by river good. (Cowan Diary, op. cit.)

March 30, 1868: We can safely challenge any country situated north of Lat. 40 to produce a record of finer weather than we have enjoyed since the 15th of February. Hardly a particle of snow has felled since that date and the amount of snow has been sufficient to ensure good sleighing until within the last two weeks- The snow is rapidly disappearing and every indication betokens an early spring with no great amount of high water. (Nor' Wester Newspaper)

- the thaw continued through April, with breakup after the 22nd and a prediction of low water

April 21, 1868: snowing ground white...snow on plains nearly 6 ins. (Cowan Diaries, op. cit.)

April 22, 1868: ...snow all gone-river open main river blocked. (ibid)

April 24, 1868: snowing a little...Bannatyne says river very low above does not believe steamer will run. (ibid)

- the end of April and beginning of May were wet and May appears to have been generally cool
- contrary to Bannatyne's prediction, water levels in late May were good, although falling in mid-June; Traill reported low water in the Assiniboine

May 23, 1868: The Steamer International arrived from Georgetown on Tuesday of last week...[Some persons] arrived on Thursday of last week from Fort Abercrombie with horses. They report the Rivers high, so much so as to necessitate rafts over all the streams except those above Grand Forks... (Nor' Wester Newspaper)

June 13, 1868: The water in the Red River is falling fast and the Steamboat people do not expect to get above Goose Rapids. (ibid)

June 15, 1868: The boats had come down slowly owing to the low water which had prevented all thought of sending up the steamer [up the Assiniboine for a trial run]... (Walter Traill at Portage la Prairie, quoted in Atwood, M., 1970. In Rupert's Land: Memoirs of Walter Traill. McLelland &

Stewart, Toronto, p. 116)

- based on slight information, summer weather appeared normal with periodic rain; water levels in the Red remained adequate for the steamboat to the end of July at least

July 31, 1868: The steamboat arrived this morning about 1 a.m. from up river. (Nor' Wester Newspaper)

- the first half of September was wet

September 15, 1868: We have had intermittent rains, of a few hours durations, for the last ten days. We may look for a day or two longer of lowery weather. (ibid)

1868-69 **- NORMAL**

- October was cold with considerable precipitation early in the month and freezeup beginning by November 1 but not completed until a week or more later

November 1, 1868: The river froze over this morning. (A Journal of Daily Occurrences at Lower Fort Garry Commenced on the 1st Day of Oct. 1868. HBCA B.303/a/1 1868/74)

November 4, 1868: The man could not cross the river the ice being too weak... (ibid)

November 7, 1868: The weather has been unusually changeable of late, but we confidently look for our Indian summer before winter weather sets in...Ice is floating on the river and there is every appearance of an early winter...The slight fall of snow experienced by us early in October, seems to have been pretty wide spread, we gather from our exchanges that it visited various parts of Canada, Minnesota and northern Missouri. (Nor' Wester Newspaper)

- the first half of November was cold with frequent snow until mid-month when it became much milder and dry until early December

December 5, 1868: We have had most delightful weather since our last issue, affording a pleasant season to those who have gone to freight in the relief supplies. (ibid)

- frequent and occasionally heavy snow was reported from mid-December to the end of the month

December 24, 1868: Dr. Brown reports the late fall of snow to be sufficient for the transportation of any freight requiring to be brought in from Abercrombie. It is badly drifting in some places, but as a general thing, the roads will be good. (ibid)

- little information exists about January weather in the Red River settlement but by the end of January, the Fort Ellice Journal reported that little snow had fallen in that region (Fort Ellice Journal, HBCA B.63/a/10 1868-69)
- by early March, snow cover appears to have been somewhat lighter than usual at the Red River Settlement

March 6, 1869: The depth of snow [normally] varies from one to two feet on the level. It is about one foot this winter, and last winter it was about eighteen inches in depth... (Nor' Wester)

- a strong thaw began in late March with rain; breakup occurred on April 21-22
- high water was reported in the southern Red River basin (PART B) while concerns about

low water were expressed in the Red River Settlement (PART B)
- actual water levels in the spring, however, were good all along the river

> May 1, 1869: The flatboats and batteaux have been coming in pretty briskly during the past week from up river. Tow flat boats arrived on Sunday 25th and up to the 26th seven boats arrived...these latter claim to have made the trip in 11 days from Abercrombie and it is said to be the quickest on record. (Nor' Wester Newspaper)

- the weather at the Settlement from May to August seems to have been cool in the first half of the summer, though otherwise unexceptional
- heavy rain must have fallen over the summer upstream of the Settlement because of reported rising water levels in late summer (PART B)

1869-1870 **- HIGH**

- the river froze on October 24, broke up on November 2, and refroze on November 7 (Fort Garry Journal of Occurrences, HBCA B.303/a/1)
- relatively mild weather occurred throughout November and at least until mid-December, with only a moderate snowfall

> November 23, 1869: Although the weather has been cloudy for the past fortnight a very small quantity of snow has fallen. We have now about four inches in depth, and the sleighing will be tolerably good upon the highways. The ice upon the rivers is not yet sufficiently thick and continuous to afford a good road. (Nor' Wester and Pioneer Newspaper)

- no further information is available until April, 1870
- April began very warm, producing an early breakup and strong freshet

> April 1, 1870: Weather still warm and pleasant. A great deal of water on the ice. Snow rapidly disappearing. (Alexander Begg in Morton, W.L. (ed.), 1956. Alexander Begg's Red River Journal and Other Papers Relative to the Red River Resistance of 1869-70. The Champlain Society, Toronto, p. 348)
>
> April 3, 1870. Weather still continued fine and the ice on the river is beginning to look dangerous. (ibid, p. 350)
>
> April 5, 1870: The weather was very warm to-day and the river now looks and in fact is quite unsafe. (ibid, p. 351)
>
> April 8, 1870: The weather today was fine with a very warm wind-the river rising rapidly and the ice breaking up. (ibid, p. 353)
>
> April 9, 1870: The river open in front of St. Boniface. (ibid, p.355)
>
> April 10, 1870: The water is high...Several bridges in the settlement have been injured from freshets but there seems to be no danger of a general flood. (ibid, p.355)
>
> April 12, 1870: The river is now quite open and rose considerably to-day. (ibid, p. 356)
>
> April 14, 1870: ...the river rose still more to-day. (ibid, p.357)

April 16, 1870: The weather today unlike yesterday was fine and bright and warm-the late fall of snow rapidly disappeared...River rising a little. (ibid, p. 358)

April 19, 1870: Weather today was beautifully warm and pleasant. The river rose perceptibly today. (ibid, p. 359)

April 21, 1870: ...a warm shower fell in the afternoon and it cleared up altogether afterwards. Mail bags came in empty today with a note from Cavalier at Pembina stating that the roads were very bad between here and Abercrombie and that there was great chances for a freshet. (ibid, p.360)

April 26, 1870: River still rising and the creeks now almost impassable. (ibid, p. 363)

April 27, 1870: River keeping about the same. (ibid, p. 364)

April 28, 1870: ...river seemed to have lowered a little to-day. (ibid, p.364)

April 29, 1870: River falling. (ibid, p. 364)

May 14, 1870: By noon next day we were at Frog Point...The stream was in flood and it was raining. (Walter Traill, in Atwood, M., 1970. In Rupert's Land: Memoirs of Walter Traill, McLelland & Stewart, Toronto, p. 181)

- rain fell on several days between the 14th and the end of May (Diaries of Dr. William Cowan, PAM, MG2 C15 M154)
- no information is available for June but some references in August and September suggest that the summer was wet

August 28, 1870: When night again fell, the whole force had reached a spot six miles from the rebel fort. And what a night of rain and storm then broke upon the Red River Expedition!...the surface of the ground became ankle-deep in mud and water. (Butler, Sir W.F., 1923. The Great Lone Land. A Tale of Travel and Adventure in the North-West of America. Burns Oates & Westbourne Ltd., London, p.188)

August 28, 1870: It has rained upon forty-five days out of ninety-four that have passed by since we landed at Thunder Bay, and upon many occasions every man has been wet through for days altogether. (Letter, Colonel Garnet Wolseley, Fort Garry, to the Regular Troops of the Red River Expeditionary Forces, quoted in Huyshe, Capt. G.L., 1871. The Red River Expedition, London, reprinted in Manitoba Pageant, vol. 5 (3), p. 20)

September 16, 1870. People rave about the climate of Minnesota but so far I have not seen much to enjoy. The mosquitoes began on the 10th of May and have continued ever since. The weather is warm and wet, the most disagreeable summer I have seen since I left home. (Traill, op. cit., p.224)

- an entry by Butler in August *might* be interpreted as indicating that the Red was at or near bankfull but is too ambiguous to be certain

> August 18, 1870: Riding quickly down this valley we reached...the edge of some water lying amidst tree-covered banks-the water was the Red River [Butler north of Georgetown]. (Butler, op. cit., p.102)

- given the high water in the spring, possible flooding (see May 14), and the apparently very wet summer, runoff appears to have been high

PART D

SUMMARY AND CONCLUSIONS

CLIMATE:

The literature on the pre-instrumental climate of the northern Great Plains indicates that the region of the Red River basin experienced many of the characteristics typical of the waning stage of the Little Ice Age and that in many aspects related to hydrologic processes, the climate of the basin differed significantly from that of the 20th Century period of most streamflow and climatic measurements. As would be expected from evidence based primarily upon phenological phenomena, there are gaps and inconsistencies in the climatic reconstructions. Nevertheless, when the entire body of data is considered, it suggests that a "wetter" hydroclimatic environment prevailed throughout most of the 19th Century, favouring higher average runoff and more frequent flooding than has occurred during the majority of the period of record.

RUNOFF:

The frequencies of water-years in each runoff category from PART C are given in Table 7 and the time series is shown in Figure 10.

TABLE 7
DISTRIBUTION OF YEARS BY RUNOFF CATEGORY, 1793-94 to 1869-70

	Very Low	Low	Normal	High	Very High	Inconc.	No Data
Number of Years	4	11	31	12	9	8	2
% Classified Years	6.0	16.4	46.3	17.9	13.4	—	—

The distribution is biased toward the High and Very High categories and it is likely that this bias would be even more apparent if actual values were known, because the distribution is bounded (by 0) at the lower end of the range but is open at the upper end. Although dry *seasons* were somewhat more common than the classification based on water-years might imply, there were only three relatively short periods of successive Low/Very Low runoff years: 1803/04-1804/05, 1815/16-1817/18, and 1861/62-1863/64. In contrast, there were two periods of five successive High or Very High years, 1823/24-1827/28, and 1847/48-1851/52, and other periods in which a concentration of high runoff years occurred (eg. 1798-1806, 1811-1815, 1857-61).

The distribution of *measured* runoff (by water-year) at Grand Forks from 1882-83

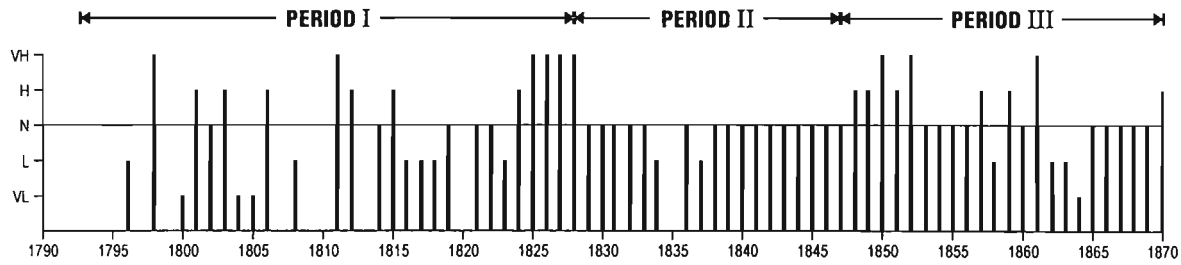

FIGURE 10: Runoff category, 1793-1794 water-year to 1869-1870 water-year

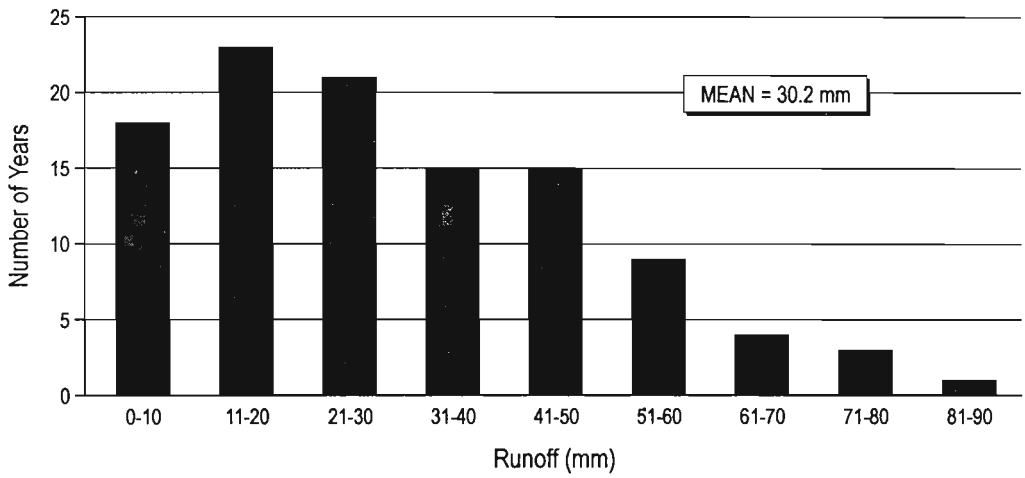

FIGURE 11: Distribution of measured runoff (by water-year) in Red River basin above Grand Forks, 1882-1883 to 1990-1991

to 1990-91 (Figure 11) is skewed toward lower runoff values. Although exact comparison of the two distributions is difficult, it is concluded that overall runoff was higher during most of the study period (prior to 1870) than during the period of record.

For discussion purposes, the study period can be divided into three intervals (Table 8).

TABLE 8
RUNOFF CATEGORY, BY TIME PERIOD

	Very Low	Low	Normal	High	Very High	Unclass.
1794-1828	3	6	5	6	6	7
1829-1847	0	2	16	0	0	1
1848-1870	1	3	10	6	3	0

Period I - 1793/94 to 1827/28: This period exhibited great variation in runoff conditions, with a high frequency of extremes. Of the 26 categorized years, only 5 were classified as normal; 46% were above normal and 35% were below. Floods and high runoff years occurred throughout the period and the years 1824-28 probably had the highest total runoff in the entire record. Periods of drought and low runoff also occurred, most notably the severe widespread drought of 1803-1805 which affected the region from the Missouri River to Lake Superior, and from 1816-1818. Three of the four largest forest fires in Itasca State Park occurred within Period I: 1803, 1811, and 1820. Assuming they have been accurately dated, the 1803 and 1811 fires probably occurred in the fall fire season since they followed high runoff water-years. No information is available about 1820 but the very large fire in Itasca may suggest extreme dryness in that year as well.

Period II - 1828/29 to 1846/47: Following the high variability of Period I were almost two decades of stable conditions, with no floods and no years classified as having significantly above normal runoff. No fires have been identified in Itasca Park and the salinity conditions in Moon Lake and the absence of drought over a large area of the Great Plains in the first half of the Period at least (PART A) suggest that good moisture conditions prevailed. The archival records contain few concerns about abnormally low water conditions. Some summer dry periods were reported but even in 1833/34, which was classified as a low runoff year, sufficient summer rainfall occurred to produce a good harvest and in *most* years, crops were satisfactory. In 1842, however, the Commissioner of Indian Affairs noted reports that the wet areas around Traverse de Sioux and Lac qui Parle in southern Minnesota were drying.

> ...For the last few years the water in all the prairies northwest of Traverse de Sioux have been rapidly diminishing. Where a few years since, were beautiful lakes several miles in circumference, now, not a drop of water can be found. Even streams dignified with the name of river, in which the Indian was accustomed to paddle his canoe, have entirely disappeared...The muskrat ponds have of course dried up... (Report of the Commissioner of Indian Affairs for 1842, Serial 413, pp. 427-431, quoted in

up... (Report of the Commissioner of Indian Affairs for 1842, Serial 413, pp. 427-431, quoted in Parker, D.D., 1964. Lac Qui Parle: Its Missionaries, Traders and Indians, South Dakota University Press, Brookings, S.D., pp. 214-5)

Depending on what is meant by "a few years since", it seems possible that this comment reflects drying after the exceptional series of five High/Very High runoff years of the late 1820's when swamp and lake areas would presumably have been greatly expanded, rather than excessive dryness in absolute terms. A series of relatively low runoff years in the mid-1830's might have begun the drying out process.

Period III - 1847/48 to 1869/70: This period was one of high runoff, with three large and several smaller floods. Runoff in most other years was classified as normal. Summer precipitation was abnormally high in several years, particularly in the late 1840's and 1850's. The only exceptionally dry period, 1862-64, was nevertheless one of the most severe droughts in the entire record. Extremely large fires in both Itasca Park and the Boundary Water Canoe Area suggest that drought conditions may have been as widespread and severe as in 1803-05.

FLOODS:

The suggested magnitudes of the historical floods and their recorded counterparts (using discharge data at Winnipeg) are given on Figure 12. Because the 1870 boundary between archival and recorded events is artificial and because the evidence in PART A suggests that the climatic shift occurred at about the end of the 19th Century, the 1882 and 1904 events have been included with the 19th Century archival floods on the figure. Flooding appears to have occurred somewhat more frequently and with somewhat greater severity in the 19th Century than in the 20th, but these differences substantially disappear when the time distribution of floods is taken into account. Whereas floods occurred throughout the 19th Century, the longest flood-free interval being twenty years from 1829 to 1849, virtually all 20th Century events occurred from 1948 onward. This is in agreement with the observations by Knox (1983) and Miller and Frink (1984), outlined in PART A, regarding the changes in flood frequency curves within the past century.

A notable difference between the pre- and post-1870 records is the number of summer or combined spring/summer events. Numerous 19th Century floods, some of considerable magnitude, were either summer events, or very late spring floods which were extended into the summer by unusually heavy summer rainfall. No such events appear in the post-1870 period. These events support the suggestion by other writers that summer atmospheric circulation over the continental interior frequently differed from the normal 20th Century patterns (PART A).

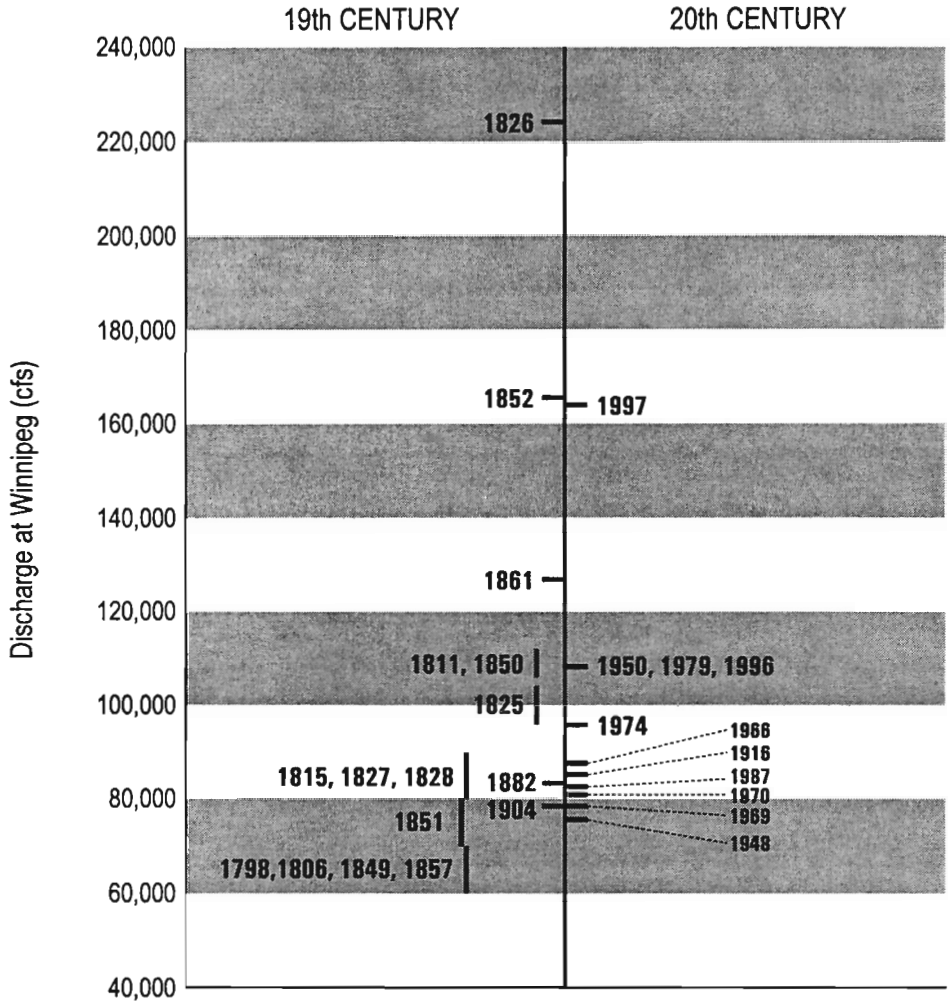

FIGURE 12: Comparison of estimated historical flood magnitudes with measured floods. Note: vertical bars for pre-1870 floods represent the suggested range

The role of the Assiniboine in the two largest 19th Century events, in 1826 and 1852, is also noteworthy. In each of these, there is evidence that conditions in the Assiniboine basin were relatively as severe as those in the Red River basin upstream of the Forks. Based on the modern record, it is likely that peak Assiniboine discharges were at least 30,000 cfs and more probably 40,000-50,000 cfs. How much of this water actually reached the Red is uncertain but if 40,000 cfs is assumed, the implied peak discharges for the Red River upstream of the Forks are 185,000 cfs in 1826 and 125,000 cfs in 1852. In 1997, a peak flow of 138,000 cfs was recorded above the Floodway and when local inputs between the Floodway and the Forks (eg. from the La Salle) are added, peak natural discharge exceeded 140,000 cfs. The 1997 flood is generally considered to have been comparable to the 1852 event but the arguments above suggest that on the Red River above the Forks it was actually larger than 1852 and may have had a peak discharge approaching 80% of the 1826 event.

Two comments in the accounts of the 1852 and 1861 floods raise the intriguing possibility that the river channel may have changed during the large 19th Century floods.

> May 21, 1852: ...The height [of the floodwaters in 1852] on the whole is certainly not so great as in the former flood, perhaps by 18 inches, but *as the river channel is deeper and broader*, and the creeks much enlarged, there may be an equal volume of water... [emphasis added]. (Anderson, D., Notes of the Flood at Red River, 1852, by the Bishop of Rupert's Land, 1852, PAM MG7 B2 CMS A83)

> June 1, 1861: ...We do not think that the country below Fort Garry will ever be flooded again for experience shows clearly that each successive flood has indicated far less depth on the plains than its predecessors--a fact fully accounted for by *the rapid widening of the river channel*. There may be the same volume of water in each flood, or very nearly so, and the *ever-increasing width of the river* will explain the disparity of depth on the main land [emphasis added]. (Nor'Wester Newspaper, June 1)

If these comments are valid, they might imply that the discharge estimates of these floods, which assumed modern channel dimensions, may have been somewhat high. This would further increase the *comparative* severity of the 1997 flood.